Eating behaviours and cardiovascular disease and diabetes risk in young Australian adults

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Declaration of originality

This thesis contains no material which has been accepted for a degree or diploma by the University or any other institution, except by way of background information and duly acknowledged in the thesis, and to the best of my knowledge and belief no material previously published or written by another person except where due acknowledgement is made in the text of the thesis, nor does the thesis contain any material that infringes copyright.

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Statement of ethical conduct

The research associated with this thesis abides by the international and Australian codes on human and animal experimentation, the guidelines by the Australian Government's Office of the Gene Technology Regulator and the rulings of the Safety, Ethics and Institutional Biosafety Committees of the University.

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Abstract

Background: Cardiovascular disease (CVD) and diabetes are major contributors to the burden of disease in Australia and their prevalence is expected to increase with the ageing of the population and the increasing prevalence of obesity. Dietary intake is known to affect cardio-metabolic disease risk but little is known about the eating behaviours of young adults and whether they are associated with diet quality and risk factors for CVD and diabetes.

Aims: To investigate whether eating behaviours (involvement in meal preparation; takeaway food consumption; number of daily eating occasions and breakfast skipping) were associated with socio-economic status, lifestyle factors, diet quality and cardio-metabolic risk factors.

Methods: Participants were 2,868 Australian adults aged 26-36 years enrolled in the Childhood Determinants of Adult Health study, a follow-up to the 1985 Australian Schools Health and Fitness Survey. Participants completed a food frequency questionnaire, a food habits questionnaire and a meal patterns chart. In childhood, participants were asked if they usually ate before school. Cardio-metabolic risk factors assessed in adulthood included waist circumference, fasting glucose, fasting insulin and lipids.

Results: Participants who were single, less educated, current smokers and less physically active tended to be higher consumers of takeaway food, eat fewer times per day and skip breakfast. Frequent takeaway food consumption, having a low number of daily eating occasions and skipping breakfast as an adult were behaviours associated with poorer diet quality. In addition, those who ate takeaway at least twice per week, had low number of daily eating occasions (men only), and skipped breakfast both as a child and an adult had a larger waist circumference compared to those who did not have these eating behaviours. Involvement in meal preparation was not strongly associated with diet quality or weight status. Cardio-metabolic risk factors were associated with eating behaviours: fasting glucose, insulin and HOMA with frequent takeaway food consumption for women; fasting glucose, insulin and lipids with low number of eating occasions for men; and fasting insulin, total and LDL cholesterol with skipping breakfast in both childhood and adulthood.

Conclusions: Eating behaviours were associated with diet quality and cardio-metabolic risk factors in young Australian adults. Simple public health messages that promote limiting takeaway food consumption to once per week and the importance of not skipping breakfast may help reduce the risk of CVD and type 2 diabetes.

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"You have brains in your head.

Your have feet in your shoes.

You can steer yourself

any direction you choose,

You're on your own. And you know what you know.

And YOU are the guy who'll decide where to go."

Dr Seuss

Oh, the places you'll go!

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Abbreviations

AEC – Australian Electoral Commission

AGHE – Australian Guide to Healthy Eating

ANOVA – analysis of variance

ASHFS – Australian Schools Health and Fitness Survey

BMI – body mass index

CARDIA – Coronary Artery Risk Development in Young Adults

CDAH – Childhood Determinants of Adult Health

CI – confidence interval

CV – cardiovascular

CVD – cardiovascular disease

DALY – disability adjusted life years

FFQ – food frequency questionnaire

FHQ – food habits questionnaire

HDL – high density lipoprotein

HOMA – homeostasis model assessment

IPAQ – International Physical Activity Questionnaire

LDL – low density lipoprotein

LTPA – leisure time physical activity

NDI – National Death Index

NCEP – National Cholesterol Education Program

PR – prevalence ratio

SES – socio-economic status

SBP – systolic blood pressure

SD – standard deviation

TV – television

UK – United Kingdom

USA – United States of America

WC – waist circumference

WHO – World Health Organization

Statement of authorship

The data used in this thesis comes from the Childhood Determinants of Adult Health (CDAH) study, which is a large national cohort study of Australian adults. The data collection was complete when Kylie Smith (KS) joined the CDAH team and therefore she was not involved in the study design or the data collection. KS had sole responsibility for cleaning the data from the dietary questionnaire (logic and range checks, manually edited the responses to the food frequency questionnaire and in a random sample of participants checked entries in the database to the responses in the questionnaire) and designed the research questions covered in this thesis based on the data available.

This thesis includes papers for which KS is not the sole author. KS took the lead in this research in that she designed the research, cleaned and analysed the dietary data and wrote the manuscript. However, she was assisted by the co-authors. The contributions of each author are detailed below.

The paper reported in Chapter 3

Smith KJ, McNaughton SA, Gall SL, Blizzard L, Dwyer T, Venn AJ. Involvement of young Australian adults in meal preparation: cross-sectional associations with socio-demographic factors and diet quality. Journal of the American Dietetic Association. 2010;110(9):1363-7.

The contribution of each author:

KS cleaned the data, undertook all the data analyses and contributed to the interpretation of the data, composed the drafts of the manuscript and coordinated revision of the manuscript.

SM provided nutritional advice and revised the manuscript.

SG provided statistical support, data interpretation and revised the manuscript.

LB provided statistical expertise and revised the manuscript.

TD was involved in the conceptualisation of the study and revision of the manuscript.

AV was involved in the conceptualisation of the study, acquisition of the data, and assisted with data interpretation and revision of the manuscript.

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The contribution of each author:

KS cleaned the data, undertook all the data analyses, contributed to the interpretation of the data, composed the drafts of the manuscript and coordinated revision of the manuscript.

SM provided nutritional advice and revised the manuscript.

SG provided statistical support, data interpretation and revised the manuscript.

LB provided statistical expertise and revised the manuscript.

TD was involved in the conceptualisation of the study and revision of the manuscript.

AV was involved in the conceptualisation of the study, acquisition of the data, and assisted with data interpretation and revision of the manuscript.

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KS was responsible for the data cleaning, statistical analysis, drafting of the manuscript and coordination of the manuscript revision.

SM provided nutritional advice and helped draft the manuscript.

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LB provided statistical support and critical revision of the manuscript.

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Publications

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Chapter 3

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Chapter 4

Smith KJ, McNaughton SA, Gall SL, Blizzard L, Dwyer T, Venn AJ. Involvement of young Australian adults in meal preparation: cross-sectional associations with abdominal obesity and body mass index. Journal of the American Dietetic Association. 2011;111:1187-91.

Chapter 5

Smith KJ, McNaughton SA, Gall SL, Blizzard L, Dwyer T, Venn AJ. Takeaway food consumption and its associations with diet quality and abdominal obesity: a cross-sectional study of young adults. International Journal of Behavioural Nutrition and Physical Activity. 2009;6:29.

Chapter 6

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Conference presentations arising from this thesis

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Oral presentations

Smith KJ*, Gall SL, McNaughton SA, Blizzard L, Dwyer T, Venn AJ. Number of daily eating occasions and breakfast skipping: associations with cardio-metabolic risk factors in young Australian adults. Oral presentation. International Society of Behavioural Nutrition and Physical Activity conference. Melbourne, June 2011.

Smith KJ*, Gall SL, McNaughton SA, Blizzard L, Dwyer T, Venn AJ. Breakfast skipping and takeaway food consumption: associations with cardio-metabolic risk factors in the Childhood Determinants of Adult Health (CDAH) study. Oral presentation. Heart Foundation conference. Melbourne, March 2011.

Smith KJ*, Gall SL, McNaughton SA, Blizzard L, Dwyer T, Venn AJ. Skipping breakfast: longitudinal associations with cardio-metabolic risk factors in the Childhood Determinants of Adult Health (CDAH) study. Oral presentation. Australasian Epidemiological Association. Sydney, September 2010. Published in the Australasian Epidemiologist 2010; 17(2).

Smith KJ*, McNaughton SA, Gall SL, Blizzard L, Dwyer T, Venn AJ. Looks who's cooking and shopping. Involvement of young adults in food purchasing and preparation: socio-demographic correlates and associations with diet and weight status. Oral presentation. Nutrition Society of Australia conference. Newcastle, December 2009. Published in the Proceedings of the Nutrition Society of Australia 2009; 33.

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Smith KJ*, McNaughton SA, Gall SL, Blizzard L, Dwyer T, Venn AJ. Takeaway food consumption, diet quality and abdominal obesity in young adults. Oral presentation. Nutrition Society of Australia conference. Adelaide, December 2008. Published in the Asia Pacific Journal of Clinical Nutrition 2008; 17 (Supplement 3).

Smith K*, McNaughton S, Gall S, Blizzard L, Dwyer T, Venn A. Takeaway food consumption and diet quality in young Australian adults. Oral presentation. Higher Degree by Research, Student Symposium. School of Exercise and Nutritional Sciences, Deakin University. Melbourne, November 2008.

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Smith K*, Paul S, Crawford D, Worsley T, Dwyer T, Venn A. The prevalence of takeaway food consumption and its association with abdominal obesity in young Australian adults. Oral presentation. Australasian Epidemiological Association conference. Hobart, August 2007. Published in the Australasian Epidemiologist 2007; 14(3).

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Other presentations

Smith K*, McNaughton S, Gall S, Blizzard L, Venn A. Eating behaviours associated with cardiovascular disease and diabetes risk in young Australian adults, PhD final presentation. Oral presentation. Menzies Research Institute seminar series. Hobart August 2010.

Smith K*, McNaughton S, Gall S, Blizzard L, Dwyer T, Venn A. Why you shouldn’t skip breakfast – reasons your mother never told you. Invited oral presentation. Dietitians Association of Australia and Nutrition Society of Australia, Tasmania seminar series. Hobart, May 2010.

Smith K*, McNaughton S, Gall S, Blizzard L, Dwyer T, Venn A. Look who’s cooking and shopping: Involvement of young adults in food purchasing and meal preparation. Invited oral presentation. Dietitians Association of Australia and Nutrition Society of Australia, Tasmania seminar series. Hobart, November 2009.

Smith K*, McNaughton S, Gall S, Blizzard L, Dwyer T, Venn A. Takeaway food consumption, diet quality and abdominal obesity in young adults. Invited oral presentation. Dietitians Association of Australia and Nutrition Society of Australia, Tasmania seminar series. Hobart, November 2008.

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Awards resulting from thesis material

2010 Awarded Australasian Epidemiological Association Student Travel award to attend their conference in Sydney, Australia.

2010 Award University of Tasmania Postgraduate Student Travel grant to attend the XI International Congress on Obesity, Stockholm, Sweden.

2009 Awarded a Nutrition Society of Australia Student Travel grant to attend their conference in Newcastle, Australia.

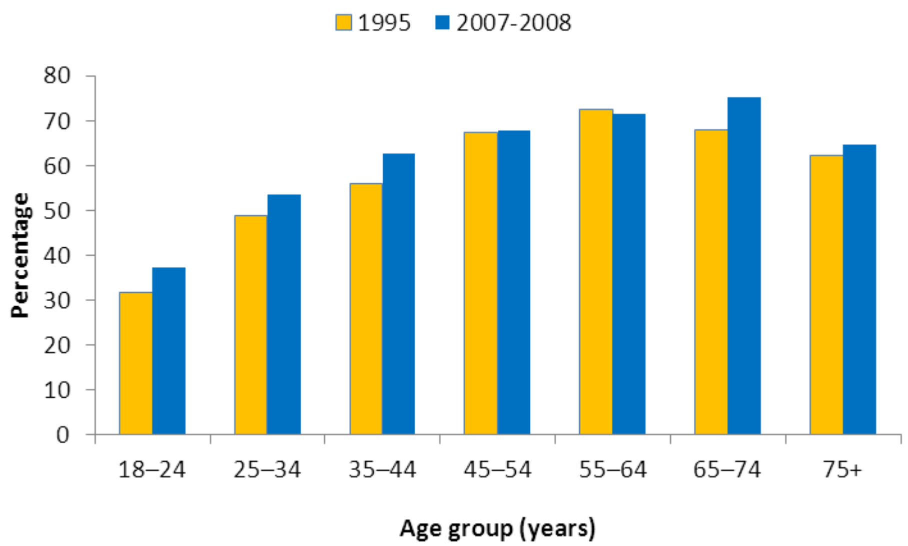
2008 Awarded a Nutrition Society of Australia Student Travel grant to attend their conference in Adelaide, Australia.

Chapter 1. Introduction

1.1 Obesity, cardiovascular disease and type 2 diabetes

For an individual, overweight and obesity are usually the result of energy intake being greater than energy expenditure. Overweight and obesity are often defined using body mass index (BMI), which is calculated by dividing weight in kilograms by height in metres squared. For adults, overweight is defined as a BMI greater than 25kg/m^2 but less than 30kg/m^2 and obesity is defined as BMI ≥30kg/m^2. The prevalence of overweight and obesity is increasing both in Australia and around the world. In 2008, the latest year for which figures are available, 37% of Australian adults aged 18 years and over were overweight and 25% were obese (1). The percentage of men classified as being overweight or obese increased from 64% in 1995 to 68% in 2007 and from 49% to 55% for women (1). The prevalence of overweight and obesity increases with age (Figure 1.1).

Figure 1.1. The proportion of Australian men and women classified as being overweight or obese in 1995 and 2008 by age



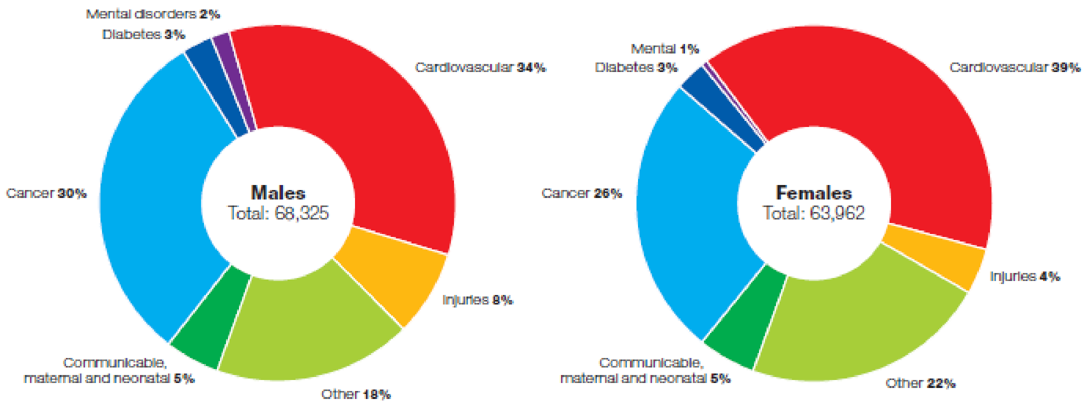
Body mass index (BMI) was calculated from measured height and weight. Overweight and obesity was defined as BMI ≥25kg/m^2 (2).

BMI is often used in large population studies because it is simple to measure and calculate. However, one of the limitations of using BMI is that it can classify people with healthy levels of body fat as being overweight because it is unable to differentiate between muscle mass and fat mass. This is a problem in individuals with a high muscle mass such as athletes. Another limitation of BMI is that it cannot determine where the fat is deposited which is important because fat distributed around the waist is more harmful than overall fatness (3). Waist circumference is an indicator of internal fat deposits, which can surround the heart, kidneys, liver and pancreas and increase risk of chronic disease. For this reason waist circumference may be a more powerful determinant of risk of chronic disease than BMI (4, 5). Like BMI, waist circumference is relatively easy to measure and requires very little equipment. In Caucasians, a waist circumference ≥94cm in men and ≥80cm for women is associated with an increased risk of developing chronic disease (3). A substantially increased risk is associated with a waist circumference ≥104cm for men and ≥88cm for women (3).

Obesity is associated with an increased risk of many conditions including cardiovascular disease (CVD) and type 2 diabetes. It is also associated with high blood cholesterol and high blood pressure. In Australia, high body mass is estimated to be responsible for 7.5% of the total burden of disease with type 2 diabetes and ischaemic heart disease accounting for almost three quarters of this burden (6).

CVD is the largest cause of mortality in Australia, accounting for 34% of deaths in males and 39% in females (7) (Figure 1.2). CVD is also a major cause of morbidity, contributing 18% to the total burden in disability-adjusted life years (DALYs). This measure takes into account years of life lost due to premature death and years of 'healthy' life lost due to disability. Worldwide, CVD is the leading cause of death killing 26.8% of men and 31.5% of women (8).

Figure 1.2. Deaths in Australia by major cause group and sex

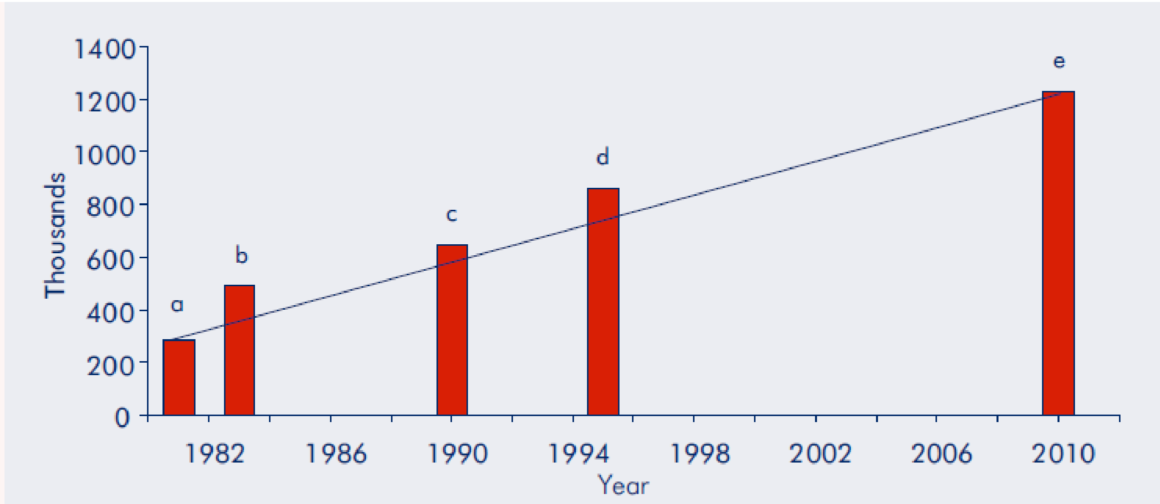


Reproduced with permission from *The burden of cardiovascular disease in Australia for the year 2003.* © 2007 National Heart Foundation of Australia (7).

It has been estimated that one in four Australians aged 25 years and older has either diabetes or impaired glucose metabolism, which is made up of both impaired fasting glucose and impaired glucose tolerance (9). In 1999-2000, 7.5% of the Australian population aged 25 years and older had diabetes, 8% of men and 7% of women (9). In addition, 17% of men and 15% of women had impaired glucose tolerance or impaired fasting glucose (10), which are strong risk factors for diabetes (9). Diabetes is the fastest growing chronic disease in Australia and it has been estimated that 275 adults in Australia develop diabetes every day (11). Figure 1.3 shows the large increase in diabetes cases in Australia since 1981 and the estimated number of persons with diabetes in 2010 of 1.23 million persons. Worldwide diabetes is becoming epidemic. In the year 2000 it was estimated there were 160 million people with diabetes and this is expected to increase to over 280 million people by the year 2025.

Diabetes is also a major risk factor for CVD. Almost three quarters of deaths in people with diabetes are from CVD (7). Of all CVD deaths, approximately 17% are attributable to diabetes (7). Impaired glucose tolerance and impaired fasting glucose are also associated with increased risk of CVD. In a national sample of Australian adults, 65% of CVD deaths over a 5 year follow-up period were in those who had diabetes, impaired fasting glucose or impaired glucose tolerance at baseline (12).

Figure 1.3. Estimated diabetes cases (number of persons) in Australia by year



Estimates of 1983, 1989-90, 1995 are based on questionnaire data and the total number of people with diabetes was calculated on the basis of there being one undiagnosed case for every diagnosed case.
a. Busselton, 1981 (13); b. NHF 1983 (14, 15); c. ABS 1989-90 (16); d. ABS 1995 (17); e. estimate.
Reproduce with permission from *Diabesity and associated disorders in Australia 2000. The accelerating epidemic. The Australian Diabetes, Obesity and Lifestyle Study (AusDiab).* © 2001 International Diabetes Institute (9).

CVD and diabetes are likely to become more prevalent in the coming decades due to the aging of the population, the increased incidence of diabetes (mainly due to the increased prevalence of obesity) and decreased mortality in those with diabetes (18, 19). Although CVD and diabetes are having a major impact on the health of Australian adults, both of these diseases are largely preventable.

The incidence of CVD and diabetes can be reduced by lowering cardio-metabolic risk factors. The cardio-metabolic risk factors of interest in this thesis are: being overweight or obese, having high total or LDL cholesterol, high triglycerides, high blood pressure, high fasting blood glucose, high insulin, insulin resistance and low HDL cholesterol.

1.2 Dietary modification, CVD and diabetes risk

Dietary factors, ranging from fatty acids, vitamins and minerals to food groups, have been shown to be associated with the risk of developing CVD and type 2 diabetes. This evidence is summarised in

Table 1.1 and Table 1.2. There is convincing evidence that fruit and vegetables, fish and fish oils, unsaturated fatty acid, potassium and low to moderate alcohol consumption are protective against CVD, whereas trans fatty acids, saturated fatty acids and high sodium intake increase risk. A recent Cochrane review of 48 intervention trials reported the quality of dietary fat is more important for cardiovascular (CV) health than reducing total fat intake (20). In trials lasting at least 2 years, CV risk was reduced when saturated fat was replaced with unsaturated fat but not when total fat intake was reduced. It is not clear whether monounsaturated or polyunsaturated fat is more beneficial for CV health (20).

Table 1.1. Summary of the strength of evidence on dietary factors and risk of developing cardiovascular disease

Decreased risk	No relationship	Increased risk
Strong evidence		
Vegetables and fruits (including berries)	Vitamin E supplements	Myristic and palmitic acids
		Trans fatty acids
Fish and fish oils (EHA and DHA)		High sodium intake
Linoleic acid		
Potassium		
Low to moderate alcohol intake (for coronary heart disease)		
Moderate evidence		
α-linolenic acid	Stearic acid	Dietary cholesterol
Oleic acid		Unfiltered boiled coffee
Non starch polysaccharides		
Wholegrain cereals		
Nuts (unsalted)		
Plant sterols/stanols		
Folate		
Weak evidence		
Flavonoids		Fats rich in lauric acid
Soy products		Beta-carotene supplements
Insufficient evidence		
Calcium		Carbohydrates
Magnesium		Iron
Vitamin C		

Table modified from *Diet, nutrition and the prevention of chronic diseases.* World Health Organization, Food and Agriculture Organization. Geneva: World Health Organization; 2003 (21).

Table 1.2. Summary of the strength of evidence on dietary factors and risk of developing type 2 diabetes

Decreased risk	No relationship	Increased risk
Moderate evidence		
Non starch polysaccharides		Saturated fats
Weak evidence		
n-3 fatty acids		Total fat
Low glycemic index foods		Trans fatty acids
Insufficient evidence		
Vitamin E		Excessive alcohol
Chronium		
Magnesium		
Moderate alcohol		

Table modified from *Diet, nutrition and the prevention of chronic diseases.* World Health Organization, Food and Agriculture Organization. Geneva: World Health Organization; 2003 (21).

There is evidence dietary modification can reduce the risk of CVD and type 2 diabetes. A Cochrane review of 38 trials concluded that dietary advice was effective in making modest beneficial changes in CVD risk factors over approximately 10 months (22). Advice given to participants focused mainly on reducing fat and salt intake and increasing intake of fruit, vegetables and dietary fibre. Dietary advice reduced total and LDL cholesterol by 0.16mmol/L and 0.18mmol/L respectively in studies ranging in duration from 2-34 months. In studies ranging from 3 to 36 months, dietary advice reduced systolic blood pressure by 2.07mmHg and diastolic blood pressure by 1.15mmHg. Although none of the trials included in the review were of sufficient duration to determine if dietary intervention could reduce CV events, it was estimated that dietary advice could reduce the incidence of coronary heart disease by 12% and stroke by 11%.

In addition to reducing the risk of CVD, lifestyle changes that include dietary modification have also been shown to reduce the risk of developing type 2 diabetes. Two large randomised controlled trials of individuals with impaired glucose tolerance reported dietary and lifestyle changes could reduce the incidence of diabetes compared to a control group. The Finnish Diabetes Prevention study (23) followed 522 overweight men and women with impaired glucose tolerance for an average of 3.2 years. During the trial the risk of developing type 2 diabetes was reduced by 58% in the intervention group. The Diabetes Prevention Program (24) compared the development of type 2 diabetes in participants with impaired glucose tolerance randomly assigned to standard lifestyle recommendations plus placebo, standard lifestyle recommendations plus metformin (a drug used to treat high blood sugar) or an intensive lifestyle intervention. The average follow-up was 2.8 years. The incidence of diabetes was 58% lower in the intensive lifestyle intervention group and 31% lower in the metformin group than the placebo group. The incidence of diabetes was 39% lower in the intensive lifestyle group than the metformin group. The benefits of lifestyle intervention or metformin in preventing or delaying the onset of diabetes was found to persist 10 years after randomisation (25). The interventions used in these trials included a combination of diet and physical activity to promote weight loss and therefore it is impossible to separate the effect of dietary changes alone.

However, a Cochrane review estimated diet alone could reduce the risk of developing diabetes by 33% over 6 years in individuals with impaired glucose tolerance (26). This estimate was based on only two studies that followed 358 participants. The Da Qing Study compared participants randomised to a diet only intervention (n=130) to those in a control group (n=133) (27). The diet only group was advised to consume 55-65% of total energy from carbohydrate, 10-15% of energy from protein and 25-30% of energy from fat. Participants were encouraged to consume more vegetables and control their intake of alcohol and simple sugars. Weight loss of 0.5-1.0 kg per month was advised for participants with a BMI above 25kg/m^2, until a BMI of 23kg/m^2 was achieved. The cumulative incidence of diabetes after 6 years was 68% in the control group and 44% in the diet group. Thus the diet intervention group had a significant reduction in the incidence of diabetes compared with the control group.

The Oslo Diet and Exercise Study compared participants randomised to a diet only intervention (n=52) with a control group (n=43). The dietary intervention recommended increased consumption of fish and fish products and energy restriction for those who were overweight or had high blood pressure (28). After 12 months of dietary intervention there were significant reductions in insulin resistance, fasting insulin, fasting proinsulin, fasting blood glucose, BMI, fasting triglycerides and significant increase in HDL cholesterol (29).

1.3 Rationale for studying young adults

Most CVD research focuses on mid-aged or older aged adults because this is the age when the majority of CV events occur. The prevalence of both CVD and diabetes is low in young adults and it increases with age. However, disease processes start early and risk factors are present in children and young adults (30-32). The progression of atherosclerosis over the life course is shown in Figure 1.4. In adolescence, coronary fatty streaks begin to form and most persons aged 20-29 years have coronary fatty streaks of some degree (33). Fibrous plaques begin to form in the 20’s and the process continues until clinical events occur.

Figure 1.4. The natural history of atherosclerosis

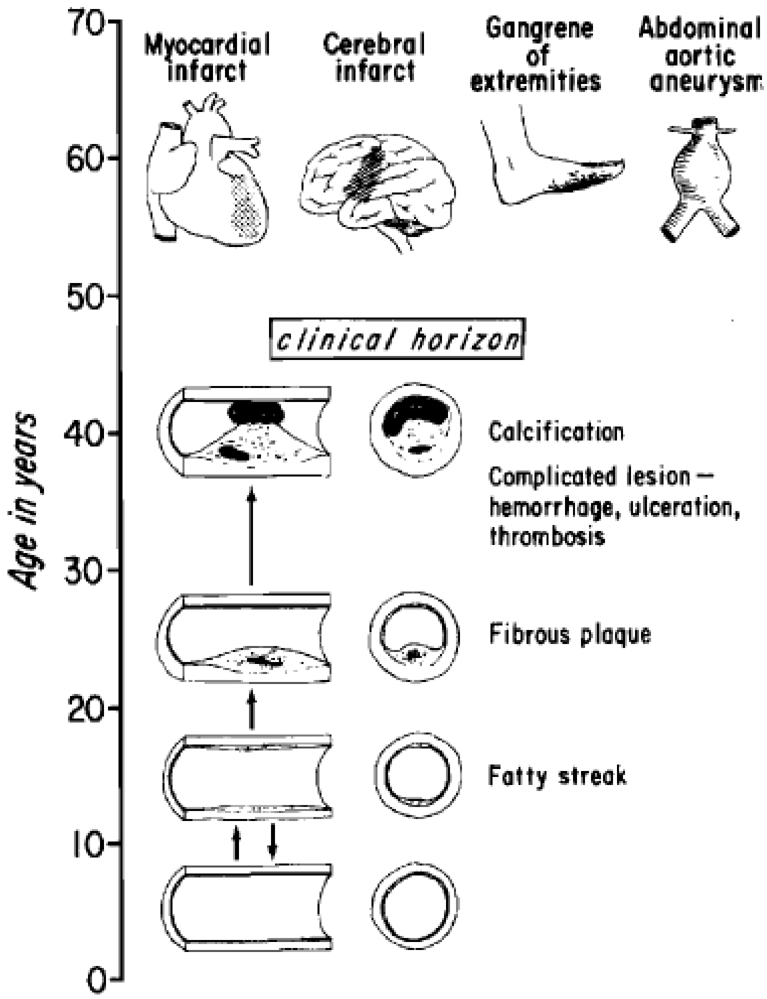


Diagram reproduced from *Early lesions of atherosclerosis in childhood and youth: natural history and risk factors.* Strong JP, Malcom GT, Newman WP, 3rd, Oalmann MC. J Am Coll Nutr. 1992 Jun;11 Suppl:51S-4S (33).

The early stages of type 2 diabetes, or pre-diabetes (impaired glucose tolerance and impaired fasting glucose), is also prevalent in young adults. A nationally representative Australian study found 5.4% of adults aged 25-34 years had pre-diabetes (9). Individuals with pre-diabetes are 10-20 times more likely to develop diabetes and CVD over a 5 year period than those with normal glucose levels (11).

These findings suggest prevention of CVD and type 2 diabetes should not begin in mid-age or older age when events commonly occur but in younger adults. Focusing on risk factor reduction in young adults has the potential to prevent CVD and diabetes before they are established or to delay the onset of these diseases. Preventing, rather than treating, CVD and diabetes will not only benefit the health of individuals but will also help to reduce the burden on the health care system.

A further reason for studying young adults is that this is a time of many life-stage transitions including completion of education and training, and increased family, work and financial responsibilities. During this time many individuals leave their parental home, start living with partners or flatmates, gain employment, have children and establish their own lifestyle behaviours. It is also a time when many have increased responsibility for their own diet.

1.4 The importance of dietary guidelines

Diet is an important modifiable behaviour for preventing obesity, CVD and other chronic diseases. Therefore, the National Health and Medical Research Council have developed the Dietary Guidelines for Australian Adults to promote evidence-based advice to the public (34). The Australian Guide to Healthy Eating (AGHE) is also used to encourage consumption of health-promoting foods and to help meet recommended daily intakes for a range of nutrients (35). The AGHE includes sex and age specific recommendations for the minimum number of daily serves from each of the five core food groups and a maximum number of serves of non-core foods.

Despite the existence of the Dietary Guidelines, poor diets are common in our community. Data from the 2008 Australian National Health Survey indicated that 95% of men and 92% of women aged 15 years and over do not have adequate intakes of fruit and vegetables (1). The importance of dietary guidelines to health was highlighted by two large studies in the USA (36, 37) that demonstrated adherence to the Dietary Guidelines for Americans reduced the risk of CVD mortality in both men (36) and women (37). Participants were given one point for each of the guidelines they met and the points were summed to give an overall Healthy Eating Index score. For men, being in the highest fifth of the Healthy Eating Index was associated with a 28% reduction in CVD risk (37) and for women there was a 14% reduction (36). When quality within the food groups was taken into account, CVD risk was reduced by 39% in men and 28% in women, independently of BMI (38). This suggests that improved diet may be able to reduce the burden of CVD. Improving diet quality is an important health priority and one of the key objectives in the Government National Partnership Agreement on Preventive Health (39).

1.5 Measures of diet quality

While the dietary intake of nutrients has been the focus of much research in nutritional epidemiology, there is an increasing focus on intakes of foods, dietary patterns and measures of diet quality. This is because intake of nutrients and foods are related, as people do not consume single foods or single nutrients but a combination of foods (40). Diet quality is usually considered in terms of adherence to established dietary guidelines or recommendations (40, 41). Commonly, a dietary index is calculated in population studies to assess adherence to a “healthy” eating pattern of interest such as Dietary Guideline recommendations (for example, the Healthy Eating Index mentioned in Section 1.4) or the Mediterranean diet. These indices focus on food groups or specific foods; nutrient intake; or a combination of foods and nutrients (40). To calculate a dietary index, points are given for each component of the diet for which the recommended intake is achieved. The points are then summed to give an overall measure of diet quality. The advantage of using this method is that indices are based on the best available evidence of optimal dietary patterns.

Another approach of dietary pattern analysis is statistical modeling such as factor analysis and cluster analysis to derive dietary patterns from the available dietary data. Dietary patterns derived through statistical modeling are data driven and are generally different for each population sample and data set. An advantage of statistical modeling is that the patterns identified reflect what individuals in populations are eating. The disadvantages are the patterns identified may not capture all relevant aspects of a healthy diet and high adherence to the optimal pattern does not mean individuals will achieve recommended or ideal intakes of nutrients or food. Therefore, these methods are not the focus of this thesis.

For this thesis, diet quality is assessed using a food based approach and defined according to the recommendations in the AGHE. Dietary intake is compared to the recommended number of daily serves for each of the five core food groups and the non-core food group. The total number of recommendations met is also calculated.

1.6 Rationale for examining eating behaviours

In addition to the types and amounts of foods consumed, another method of examining diet is the investigation of eating behaviours. Eating behaviours are the way people eat and the eating behaviours of interest in this thesis include involvement in meal preparation, consumption of takeaway food, the number and types of meals eaten during the day and whether or not breakfast is eaten. Eating behaviours have the potential to impact on health outcomes through food and nutrient intake.

Public health messages based on eating behaviours have the potential to be simple and easily understood. Focusing on the behaviour, which people recognise, may be more effective than focusing on the intake of nutrients, which people cannot calculate as easily. For example recommending a maximum number of takeaway food meals per week is easier to understand than recommending reducing saturated fat intake.

A better understanding of eating behaviours is important as it will provide much needed information on whether any of these eating behaviours are associated with diet quality and cardio-metabolic risk factors.

1.7 Eating behaviours of interest

This thesis will examine eating behaviours that have the potential to affect diet quality or cardio-metabolic risk factors through the nutritional content of the food such as high intake of total or saturated fat and/or the timing of eating occasions. These eating behaviours (involvement in meal preparation, takeaway food consumption, eating frequency and breakfast skipping) are often mentioned in the mass media as being beneficial or harmful to health, but there is very little or conflicting scientific evidence available to support these claims. Other eating behaviours such as eating while watching TV, soft drink consumption and eating dinner with family or household members may also be important but these are not examined in this thesis. Dietary intake can also be considered an eating behaviour. However, for this thesis diet quality is an outcome of interest and therefore the term eating behaviour does not include dietary intake.

1.7.1 Involvement in meal preparation

Meal preparation is included as an eating behaviour in this thesis because it is a behaviour associated with eating and has the potential to affect dietary intake. Traditionally it has been women who were responsible for meal preparation in the home. However, a large proportion of women are now in the workforce and recent Australian data show men have increased their contribution to meal preparation and clean-up. In 2006 on average, men spent 3 hours and 23 minutes per week on food preparation and clean-up, an increase of 35 minutes from 1992 (42). The amount of time allocated specifically to meal preparation was not reported. In comparison, women spent an average of 8 hours and 3 minutes per week in 2006, which was a reduction of 14 minutes from 1992 (42).

During young adulthood many individuals experience increased responsibility for purchasing and preparing their food. It is not known what level of involvement young adults have in the preparation of their meals or whether level of involvement differs by sex. In a study of young adults from the USA it was reported that those who had a high level of involvement in meal preparation had a better diet quality than those who were less involved (43). However, involvement in meal preparation was a score calculated from a number of potentially healthy meal preparation behaviours that may have biased the results (see Chapter 3). If involvement in meal preparation is associated with better diet quality, interventions to increase involvement in meal preparation may be useful for improving diet quality and reducing CVD risk.

1.7.2 Takeaway food

Although there are no standard definitions, fast food is the term used in North America and generally includes burgers, fries, pizza and roast chicken. Takeaway is the common term used in Australia and includes fast foods plus other “take-out” options such as Thai, Chinese and Indian food. It is possible takeaway food is more nutritious than fast food. The majority of previous studies have focused on fast food. Consuming foods such as takeaway and fast food is becoming more prevalent both in Australia and around the world. In Australian, income from takeaway food sales increased on average by 18% per year from 2003-2004 to 2006-2007 (44). In contrast, income from meals consumed on the premises (for example in restaurants and cafes) increased on average by only 6.1% per year. In 2007, it was estimated that fast food chains and independent outlets served 1.64 billion eat in and takeaway meals (45). This figure represents 44% of all meals served in the commercial food service sector (45).

There has been recent interest in how the consumption of takeaway food might contribute to obesity. This is suspected to be due to the large portion sizes, high fat content and energy density of common sources of takeaway food (46, 47). Portion sizes of takeaway and fast foods are often large and studies have shown when greater amounts of food are served more food is consumed (48, 49). Takeaway and fast food consumption is generally presumed to be bad for health but there is very little scientific evidence to support this. Obviously if there is a link between takeaway and fast food consumption and CVD risk, the large contribution takeaway and fast foods make to food purchased away from the home could be of high public health importance. However, very few studies have examined associations between takeaway or fast food consumption and cardio-metabolic risk factors (50, 51), other than measures of overweight and obesity.

1.7.3 Eating frequency

In recent decades there has been a move away from eating three meals a day to eating more frequently. Whether or not there is an optimal number of eating occasions for weight control and reducing cardio-metabolic risk is unclear. A meta-analysis examining the relationship between eating frequency and cardio-metabolic risk factors has not been possible due to the inconsistent definitions of meals, snacks and eating occasions used across studies. Animal studies have shown eating fewer meals or fasting on alternate days reduces body weight and blood pressure and improves glucose regulation, insulin sensitivity and CV risk profiles (52). In contrast, some, but not all, human studies show benefits with frequently eating small meals. Eating small frequent meals has the potential to improve weight status by helping to control hunger, shifting the distribution of energy intake towards earlier in the day rather than later in the day, increasing the dietary carbohydrate to fat ratio, and being more compatible with a physically active lifestyle (53). Observational studies have shown a higher eating frequency is associated with lower adiposity (54, 55), but a recent review of 15 randomised controlled trials and 10 other trials, found there was no association between eating frequency and body weight (56). Eating frequency has been shown to be associated with other cardio-metabolic risk factors in controlled trials with six or more meals per day being associated with a lower risk (57). However, the number of eating occasions that have been shown to be associated with health benefits in the intervention studies are often not practical for everyday living (such as eating 17 small meals per day). In addition, energy intake is often controlled and this removes the ability to observe the potential benefits more frequent meals may have on appetite (58, 59). Another limitation of these intervention studies is they are often in small numbers of select groups. Few observational studies in non-diabetic participants have examined associations between eating frequency and cardio-metabolic risk factors other than weight status (55, 60, 61).

1.7.4 Breakfast skipping

In the 1995 Australian National Nutrition Survey, 23% of adults and 10% of children reported they did not usually eat breakfast. There is some evidence from large nationally representative surveys in the USA that skipping breakfast has become more prevalent in recent decades. In 1965, 14.3% of men and women aged 18 years and older did not eat breakfast the day before the survey. This percentage increased to 24% in 1977-8 and 25% 1989-91 (62). Whether this trend of increased breakfast skipping is also occurring in Australia is not known.

Breakfast is often referred to as the most important meal of the day. When a healthy breakfast is eaten individuals are more likely to meet their daily vitamin and mineral requirements (63-66). Most, but not all, studies show that eating breakfast is associated with a lower risk of being overweight or obese and better weight maintenance in children, adolescents and adults (65, 67-75). In a two week randomised cross-over trial, skipping breakfast was also associated with poorer insulin sensitivity and higher fasting cholesterol concentrations (76). However, the long term effects of skipping breakfast are not known.

1.8 Aims

The aims of this research are:

1. To describe the eating behaviours (involvement in meal preparation, takeaway food consumption, eating frequency and breakfast skipping) of young Australian adults and the demographic, socio-economic and lifestyle factors associated with them.

2. To determine whether eating behaviours of young Australian adults are associated with diet quality.

3. To determine whether eating behaviours are associated with CVD and type 2 diabetes risk factors in young Australian adults.

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Chapter 2. Methods

2.1 Preface

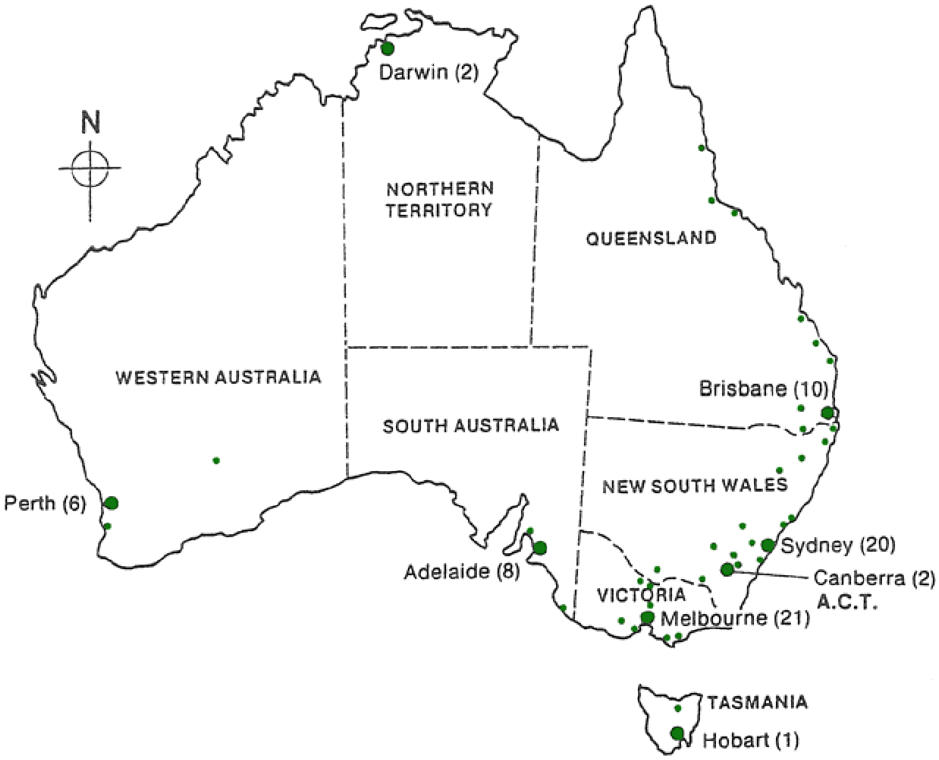
This thesis aims to describe the eating behaviours of young Australian adults and to determine whether eating behaviours are associated with diet quality and cardio-metabolic risk factors. The data used to address these aims comes from the Childhood Determinants of Adult Health (CDAH) Study. The CDAH study is a 20 year follow-up of the children who participated in the 1985 Australian Schools Health and Fitness Survey (ASHFS). Using data from repeated questionnaires and physical measures the long term aim of the CDAH study is to determine the contribution of childhood factors to the risk of developing CVD and type 2 diabetes in adulthood. This thesis examines data from the first follow-up and some childhood measures. This chapter describes the participants of the CDAH study and the methods, relevant to this thesis, that were used to collect the study data.

2.2 Australian Schools Health and Fitness Survey (ASHFS)

2.2.1 Sampling and recruitment

The 1985 ASHFS was conducted on a nationally representative sample of 8,498 7-15 year old children (1, 2). The children were selected using a two stage probability sample. The first stage involved the selection of schools with a probability proportional to enrolment. Schools with total enrolment of less than 200 students (9.9% of primary schools and 3.1% of secondary schools) were excluded from the sampling frame. To ensure a good geographical distribution, eligible schools were listed in ascending postcode order. One hundred and nine schools were then chosen using a random-start, constant-interval procedure. Twelve schools refused to participate and were replaced with 12 other schools. The school response rate was 90.1%. The distribution of the participating schools is shown on the map in Figure 2.1.

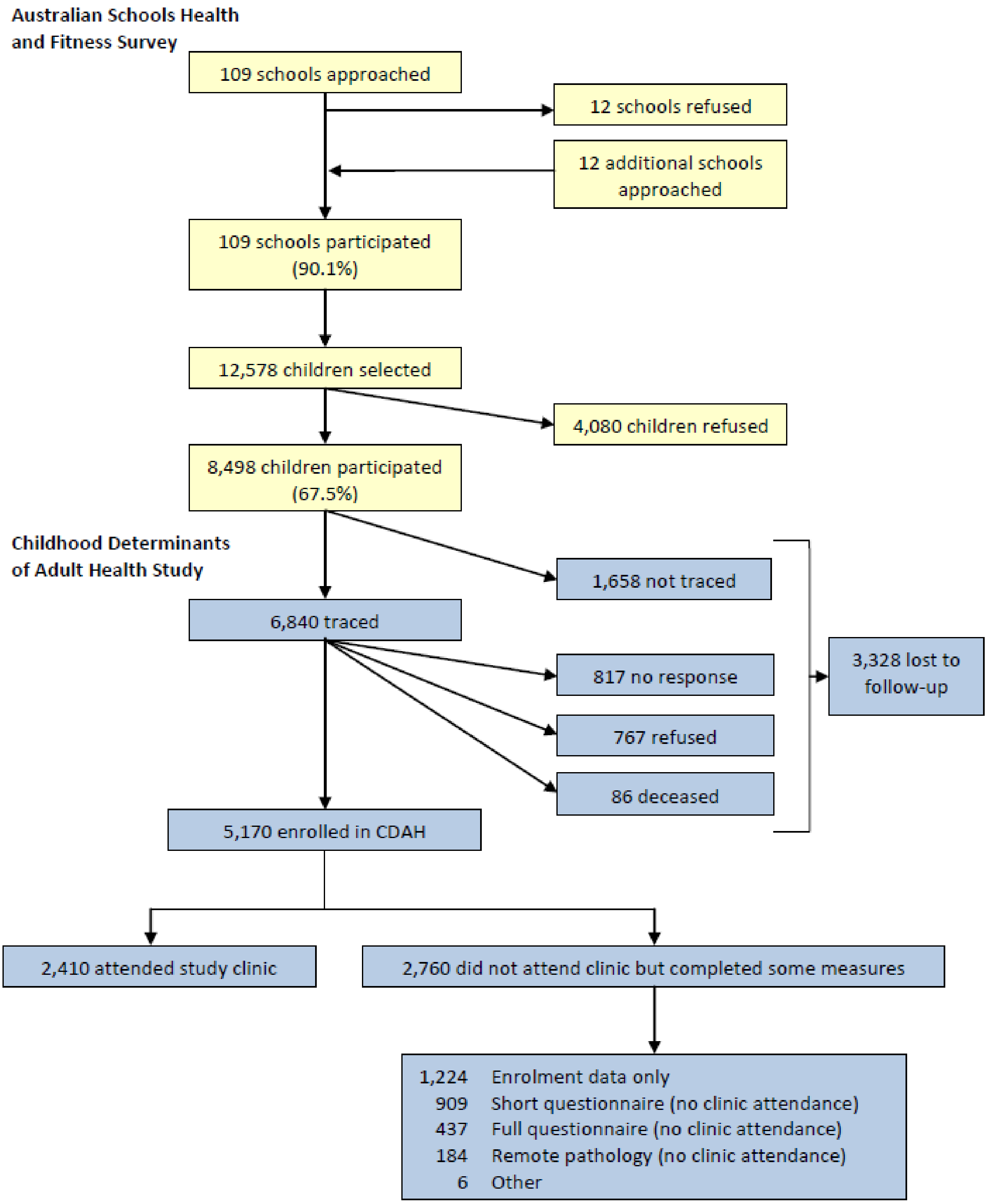
Figure 2.1. Location of the schools that participated in the 1985 Australian School Health and Fitness Survey



The second sampling stage was the selection of children using school enrolment information. The study aimed to have 500 boys and 500 girls from each year of age. Fifteen children from each age and sex category were chosen from each school to allow for non-participation. Only data from 10 students from each age and sex category per school was used. In total, 8,498 (67.5%) children participated in the study (Figure 2.2).

The survey measurements included a range of health, lifestyle, physical fitness and physical performance parameters. Children aged 9-15 years old (n=6,559) completed a questionnaire on demographics, diet and physical activity in small supervised groups. Children aged 7-8 years (n=1,939) were thought to be too young to answer the questionnaire reliably so they were not asked to complete it. Children aged 10 years and older were also asked to complete a 24-hour food record. A 24-hour record is not considered a measure of usual intake and the method used to collect the dietary data in childhood was different to the methods used in adulthood (food frequency questionnaire, food habits questionnaire and a meal patterns chart, see section 2.4). Therefore, this thesis mainly focuses on cross-sectional analysis of the adult dietary data, with the exception of Chapter 8 (Skipping breakfast: longitudinal associations with cardio-metabolic risk factors in the Childhood Determinants of Adult Health (CDAH) study).

Figure 2.2. Participation in the Australian Schools Health and Fitness Survey and the Childhood Determinants of Adult Health Study



2.3 The Childhood Determinants of Adult Health (CDAH) study

2.3.1 Tracing and recruitment

The ASHFS was not intended to be a longitudinal study, therefore there was limited information available for tracing participants. This information included the child's first and last name and school attended. Date of birth was available from class lists or questionnaires for 7,564 (89%) children and 6,416 (75%) had a postcode of residence in 1985. A pilot study to test the tracing methods was conducted in 2001 and tracing occurred between 2002-2004.

Names and dates of birth were sent to the Australian Electoral Commission (AEC) and the Australian Institute of Health and Welfare National Death Index (NDI). In Australia it is compulsory for Australian citizens to register at the electoral office at the age of 18. The AEC provided addresses for 4,183 participants (55%). However, 51% of these addresses were out of date. The NDI had 137 matches (1.6%) and 80 of these were considered to be definite matches. During the tracing process, a further 28 participants not identified by the NDI were reported to have died.

For participants who did not have a current address recorded at the AEC, methods were used to trace either the participant or members of their family. Historical electoral rolls were used, starting in the year closest to their 18th birthday, to obtain more complete name details to help with tracing. Current and historical electoral rolls were also searched for potential family members still living in the same area as the participant in 1985. If participants were not on the electoral roll, the electronic white pages, "Australia on Disc™" (a reverse telephone directory where an address can be looked up to find the names of people living there), and Alumni "School friends" websites were used.

Once an address was found, an information brochure on the CDAH study, an invitation to participate and an enrolment questionnaire were sent. The enrolment questionnaire collected information on socio-demographics, self-reported height and weight, smoking status and overall health. After two weeks, non-responders were contacted by phone and invited to enrol in the CDAH study and to complete the enrolment questionnaire over the phone. If non-contactable by phone, a postcard was sent asking them to contact the CDAH team. Additional tracing methods included sending study information and letters to schools that participated in the ASHFS and sending press releases to local papers near participating schools. Once recruited, participants were encouraged to inform staff of any change of address using a toll free phone number or via email.

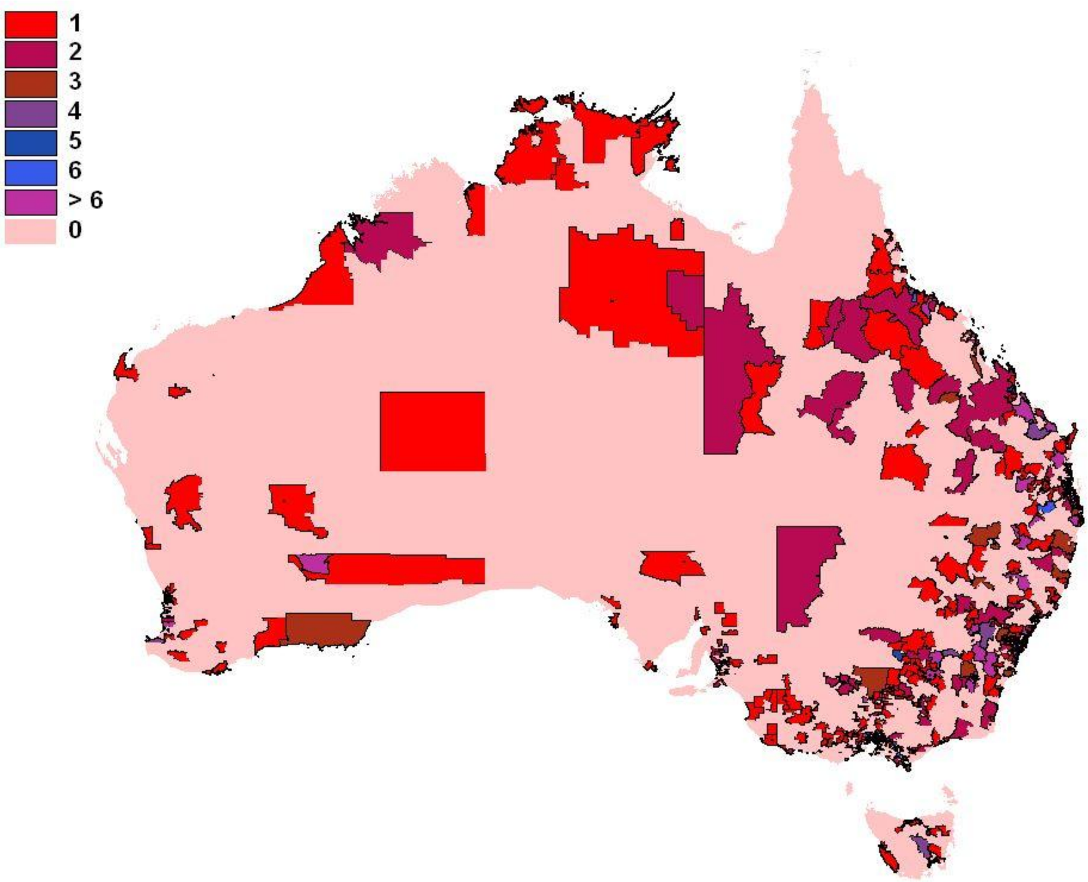
Participants were invited to attend a study clinic and were contacted two months before the clinic to arrange an appointment. Two weeks before the clinic three questionnaires (general, diet and physical activity) and detailed information about the clinic were posted to the participant. Participants were asked to fast for 12 hours before their appointment and to bring their completed questionnaires to the clinic.

2.3.2 Study clinics

Clinics were held during 2004-2006 in each state and territory: nine in New South Wales/Australian Capital Territory (n=720), eight in Victoria (n=705), eight in Queensland (n=497), three in Western Australia (n=205), three in South Australia (n=190), two in Tasmania (n=55) and one in the Northern Territory (n=38). The locations of the clinics were determined by mapping participants' current postcode (Figure 2.3) using Geographic Information Systems and selecting areas which would be convenient and accessible to as many participants as possible. Clinic venues included community centres, schools, community halls, church halls and other similar venues. The clinic locations were chosen to maximize the proportion of enrolled participants living within a 10km radius and 55% of enrolees living within this distance attended. In some states clinics were held up to three years after initial enrolment.

The data collection teams included ten data collectors, a field co-ordinator and a trained venipuncturist. Training was conducted before data collection began in each state over a two day period. Training for each test was conducted by the same person for each state and territory.

Figure 2.3. Distribution of CDAH participants according to postcode as of January 2004



The clinics took approximately three hours to complete. Signed consent was obtained on arrival at the clinic and the completed questionnaires were collected. If participants had not completed their questionnaires or forgot to bring them to the clinic they were given a reply-paid envelop and asked to return them at their earliest convenience.

The clinics included eight measurement stations. The stations had to be completed in a specific order. However, the components within each station could be completed in any order before going on to the next station.

Station 1: anthropometry, ultra sound, blood pressure

Station 2: blood collection

Station 3: breakfast

Station 4: mental health (self-completed questionnaire on a laptop computer)

Station 5: bone density, lung function

Station 6: cardiorespiratory fitness

Station 7: muscular fitness

Station 8: issue of pedometer and pedometer diary

At the end of the clinic participants returned to the registration desk to ensure they had completed the consent form, questionnaires and all clinical assessments. Participants were then given a "thank-you" bag containing items from local and national businesses including pamphlets, information leaflets, pens, stickers, keyrings and occasionally movie vouchers.

Data from the clinic forms, questionnaires and pedometer diaries were scanned and verified using Teleform (Verity Teleform, Version 9, USA). Data were verified manually and double checked to ensure accuracy. For quality assurance, data collected during the first week in each state was fast-tracked through the scanning and verifying process so differences in the average values between the newest data and the data already in the database could be detected.

Participants who enrolled in the CDAH study but refused to attend a full clinic were given alternative options, in the following order: short clinic protocol (blood test, blood pressure and anthropometric measurements, questionnaires); visit local pathology centre for a blood test; complete mailed questionnaire and seven day pedometer; mailed questionnaire without pedometer; full questionnaire via phone; short questionnaire with key questions from the full questionnaire administered by mail or over the phone. As a result of these different options full data is not available for all participants. Table 2.1 shows the number of participants with data available for the measures of interest in this thesis.

Table 2.1. Number (%) of participants with data for exposure and outcome variables of interest

	Men		Women		All	
Variable	n	%	n	%	n	%
Completed dietary questions of interest[a]	1280	100	1588[b]	100	2868	100
Usable FFQ data (completed ≥90%)	1239	96.8	1452	91.4	2691	93.8
Waist circumference measurement	1068	83.4	1131	71.2	2199	76.7
Fasting blood sample	1071	83.7	1137	71.6	2208	77.0

[a] Who prepares the main meal, frequency of takeaway food consumption, meal patterns chart.
[b] Includes 78 women who were pregnant. These women were excluded from the analysis of diet quality and cardio-metabolic risk and are not included in the totals for the other variables in this table.

2.4 Measures of dietary intake

Food intakes and dietary habits were assessed using a food frequency questionnaire (FFQ), a food habits questionnaire (FHQ) and a meal patterns chart (Appendix 9).

2.4.1 Food frequency questionnaire

Participants completed a self-administered FFQ which included 127 food and beverages. Participants were asked to report how many times in the previous 12 months they had consumed each item. There were nine response options ranging from “never or less than once a month” to “6+ times per day”. These categories have been widely used in FFQs, including the Nurses Cohort Study in the United States (3, 4). The questionnaire did not ask about serving sizes and therefore a value for energy intake and other nutrients is not available. The FFQ was a modified version of the one used in the 1995 National Nutrition Survey (5-8) which was based on an existing FFQ developed for Australian populations (9). Appendix 2.A shows the differences between the CDAH FFQ and the FFQ used in the 1995 National Nutrition Survey.

The food list on the FFQ included some commonly consumed mixed foods including stir-fried vegetables and salads as distinct items. Other foods such as sandwiches were not listed and participants were asked to think about the separate ingredients that made up the item. For example if a ham and mixed salad sandwich was eaten once a week and no other ham or mixed salad was eaten during the week, the “once per week” option would be selected for ham and for green/mixed salad. The bread or roll would be included in the breads total.

For very seasonal fruits such as stone fruits, participants were asked to estimate their average consumption when the fruits were in season. For example, if apricots were eaten once per day during summer, and no apricots were eaten for the rest of the year, the response “once per day” would be selected.

The FFQ was designed for one answer per line. When more than one option was chosen the response was edited manually following the guidelines in Table 2.2 (9). Completely blank lines or lines with unresolved errors were recorded as missing ('.'). A FFQ that was missing responses to 10% or more of the items was classified as unusable (n=99).

Table 2.2. Guidelines for manually editing the food frequency questionnaire when more than one response was selected

Error	Correction
Completely blank line	Record as missing ('.')
Line with two marks and more than one food	Record the higher frequency category
Line with two marks and exactly one food	If the responses are adjacent, record the higher frequency category If the responses are separated by an odd number of categories, record the middle category Otherwise, record the category to the right of the middle
Line with more than two marks and at least the same number of foods	Record the highest frequency category
Line with multiple marks, clearly not connected to the number of foods	Record as missing ('.')

Daily equivalents were calculated for each food and drink item in the FFQ, assuming one serve was consumed at each occasion (5, 10). The mid value was used when the response option included a range of values (for example 2-4 times per week) and missing values were given a value of zero. The daily equivalents were calculated for each item using the conversion factors shown in Table 2.3. Daily equivalents were summed to give a value for each food group.

Table 2.3. Calculation of daily equivalent values from the food frequency questionnaire

FFQ frequency	Daily equivalent	Calculation
Never or less than once a month - alcohol	0	0
Never or less than once a month	0.02	0.5/30
1-3 times per month	0.07	2/30
Once per week	0.14	1/7
2-4 times per week	0.43	3/7
5-6 times per week	0.79	5.5/7
Once per day	1	1/1
2-3 times per day	2.5	2.5/1
4-5 times per day	4.5	4.5/1
6+ times per day	6	6/1

2.4.2 Food habits questionnaire

The FHQ was developed by researchers at The Centre for Physical Activity and Nutrition Research, Deakin University, Melbourne, and collected information on the food-related behaviours listed below.

Involvement in food purchasing and meal preparation

The person responsible for purchasing the food and preparing the main meal was identified using the following two questions: “Who normally buys the groceries for your household?” and “Who normally prepares your main meal at home on working days?” Response options were “nobody/I do not have meals at home on working days”, “myself”, “my partner”, “my mother or father”, “someone else (please specify)”, “myself, together with (please specify)”.

Frequency of takeaway food consumption

Takeaway food consumption was assessed using the question “How many times per week would you usually eat hot takeaway meals (*e.g. pizza, burgers, fried or roast chicken, Chinese/Indian/Thai takeaway*)”. Participants could choose one of five answers ranging from “I don’t eat takeaway” to “6-7 meals per week”.

Fruit and vegetable consumption

Daily fruit and vegetable consumption came from the two short questions “How many serves of fruit do you usually eat each day?” and “How many serves of vegetables (excluding potatoes) do you usually eat each day?” Examples of serving sizes were given and the response options were “I don’t eat this food”, “1 serve or less”, “2-3 serves”, “4-5 serves” or “6 or more serves”. Short questions have been used in previous studies (5, 11) and have been shown to be valid measures for fruit and vegetable intake (12).

Trimming fat from meat

Participants were asked “How often is the meat you eat trimmed of fat either before or after cooking?” Response options were “never/rarely”, “sometimes”, “usually” and “I don’t eat meat” (9). This information was used to calculate the daily equivalents of lean meat.

Special diet

Participants were asked “Which one of the following best describes your usual way of eating?” Response options included “vegetarian”, “weight reduction diet”, “diabetic diet”, “fat modified diet”, “other (e.g. vegan, salt free)” or “no special way of eating” (9). Participants who reported they were on a weight loss diet were excluded from some analyses.

2.4.3 Comparison of dietary intake with dietary recommendations

Questions from the FFQ and the FHQ were used to determine if participants were complying with sex and age-specific recommendations in the Australian Guide to Healthy Eating (AGHE) (13). The AGHE has been developed to encourage the public to adopt healthy eating patterns by highlighting the foods that help meet nutrient recommendations and provides two sets of recommendations based on different patterns of eating. The recommendations used in the analyses for this thesis are the most commonly used and are consistent with the public health messages promoting consumption of five serves of vegetables and two serves of fruit per day (14). These recommendations are also the more conservative of the two for fruit, vegetables and dairy for men. The recommendations for 19-60 year old men and women are shown in Table 2.4.

Table 2.4. Australian Guide to Healthy Eating dietary recommendations for 19-60 year old men and women

	Recommended number of serves per day	
Food Group	Men	Women
Cereals	6-12	4-9
Vegetables/legumes	5	5
Fruit	2	2
Milk, yoghurt, cheese	1	1
Lean meat, fish, poultry, nuts and legumes	1	1
Extra foods (have no more than)	0-3	0-2½

Foods that do not fit into the five food groups are “extra” foods and are high in fat, salt and sugar and provide very few essential nutrients (13). The AGHE recommends these foods to be eaten in small amounts. Examples of extra foods include ice cream, cream, cakes, sweet pies, dessert, sweet biscuits, chocolate biscuits, savoury pastry, pizza, hamburgers, hot chips, fried fish, chocolate, other confectionary, crisps, dressings, mayonnaise, jam, creamy dips, fruit drink, cordial, soft drink and all alcohol. The guidelines recommend limiting the number of “extra” foods to no more than three servings per day for men and no more than two and a half servings per day for women, depending on energy requirements.

For comparison with the AGHE, information on daily servings of fruit and vegetables came from the short questions in the FHQ. Participants were classified as meeting the recommendation for vegetables if they ate at least four servings of vegetables per day because in the response options four and five serves per day were combined. Daily serves of cereals, dairy, lean meat and alternatives and extra foods were obtained from summing daily equivalents calculated from the FFQ (see Appendix 2.B for items included in each food group). For breads and cereals the lowest value in the recommended intake range was used and for extra foods participants not exceeding the upper limit were classified as meeting the recommendation. In line with the Dietary Guidelines for Australian

Adults (15) and the AGHE (13) high fat meats were not included in the meat and alternatives food group. However certain meat items that would be considered lean if all visible fat was removed, were included as lean meats (see Appendix 2.B) if participants reported in the FHQ that they "usually" trimmed the fat from their meat before or after cooking.

2.4.4 Meal patterns

The dietary questionnaire included a meal patterns chart similar to the one used by Berteus Forslund et al (16). Participants were asked to complete the meal patterns chart for the previous day and to record which day of the week that was. The chart was divided into hourly intervals from 6am to 11pm and the hours 11pm-6am were combined. For each time interval participants were asked "Did you eat anything?" Possible response options were "no", "a snack", "a small meal", or "a large meal". In the instructions, the following examples for each meal type were given: snacks - a piece of fruit or a biscuit; small meals - beans on toast, boiled egg and bread, breakfast cereal, a pie or a pastie; large meal - meat and three vegetables, or a large serving of fish and chips.

Beverage consumption was also assessed at each time interval with the question "Did you drink anything?" The response options were "no", "alcohol", "water" or "something else". More than one type of drink could be selected for each time period, for example alcohol and water. If participants selected "no" (for example, did not have anything to eat or drink) and also selected one of the meal or drink options during the same time period, it was assumed that the "no" was an error and the meal or drink specified had been consumed.

One man twice reported eating two large meals at consecutive time points: 8am-9am, 9am-10am, 6pm-7pm and 7pm-8pm. It was assumed this individual either started eating on the hour shared by the two time points (9am or 7pm) and therefore selected both time points, or he started eating in the first time period and finished in the second. For the analysis the second eating occasion was removed.

2.5 Clinic Measures

2.5.1 Anthropometric measurements

For all anthropometric measurements participants were standing and dressed in light clothing without shoes. Participants were asked to remove outer layers of clothing, tight garments intended to alter body shape (such as corsets, lycra body suits and support tights), belts and heavy items from their pockets. Measurements were taken by trained staff following standardised protocols. All staff were trained by the same qualified anthropometrist. In total, seven staff took the anthropometric measurements. Halfway through the clinics in each state and territory, the trainer attended a clinic to check technique. Anthropometric measures were not taken on pregnant women (n=78).

Waist circumference

Waist circumference was measured three times over light clothing at the narrowest point between the lower costal border (10th rib) and the iliac crest, at the end of normal expiration. Measurements were taken using a Lufkin steel (non-stretch) tape measure and were recorded to the nearest 0.5cm. If the first two measurements were the same, a third measurement was not taken. Mean waist circumference was calculated.

Moderate abdominal obesity was defined as ≥94cm for men and ≥80cm for women. These cut points were defined by the World Health Organization (WHO) and are associated with an increased risk of metabolic complications associated with abdominal obesity (17).

Weight

Body weight was measured using a Heine portable scale (Heine, Dover, NH, USA) and recorded to the nearest 0.1kg. The scales were calibrated by an external calibration service before the first clinic in New South Wales, Australian Capital Territory, Western Australia and Victoria.

Height

Height was measured to the nearest 0.1cm using a portable Leicester stadiometer (Invicta, Leicester, UK). The head was held in the Frankfort horizontal plane and any obstructive headwear was removed.

Body mass index

Body mass index (BMI) was calculated from height and weight using the equation weight (kg) / height $(m)^2$. Overweight was defined as BMI ≥25.0-29.9kg/m^2 and obese was defined as ≥30kg/m^2.

2.5.2 Blood pressure

Blood pressure was measured using an Omron HEM907 Digital Automatic Blood Pressure Monitor (Omron HEM907, Omron Healthcare Inc, Kyoto, Japan) that was calibrated at the start of each session. Participants had been sitting comfortably with their legs uncrossed for at least 5 minutes before the first measurement was taken and the right arm was used for the measurement. Upper arm girth was measured to determine the appropriate cuff size. Three consecutive measurements of systolic and diastolic blood pressure were recorded with a one minute interval between each measurement. The mean of the three measurements was used for analysis. If the cuff did not fit because the participant was obese, or if a reading could not be obtained, blood pressure was measured manually using a sphygmomanometer (Accoson Dekamet Mk3, London, UK) with at least one minute intervals between each measurement.

2.6 Blood biochemistry

2.6.1 Blood collection

A 30ml fasting blood sample was collected from the antecubital vein after an eight hour fast by a trained venipuncturist. Samples were collected into white-top (serum gel) vacutainer tubes for lipid and insulin analysis and grey-top (fluoride additive) vacutainer tubes for glucose. The white-top tubes were left to stand at room temperature for approximately 15 minutes to coagulate before being centrifuged. All samples were centrifuged within two hours of venipuncture and stored upright at approximately 4°C. After centrifugation, serum was collected from the top layer of the white-topped tube and plasma in the grey-topped tube was separated from the red blood cells. At the end of each clinic, samples were sent to the laboratory (Medvet, Adelaide, South Australia) in insulated containers with cold packs via overnight courier. On 12 random clinic days temperature data loggers were included in the insulated containers. The mean temperature during transport was 2.6°C (range 0.7 to 3.6°C).

2.6.2 Blood analysis

The serum sample was used to measure lipids and insulin and the plasma sample was used to measure glucose. Triglycerides, total cholesterol, HDL cholesterol and glucose were analysed enzymatically on an Olympus AU5400 Mira plus autoanalyser (Olympus Optical, Tokyo, Japan). LDL cholesterol was calculated using the Friedewald formula (18).

Fasting plasma insulin was measured by micropartical enzyme immunoassay kit (AxSYM, Abbot Laboratories, Abbot Park, Illinois, USA) or electrochemiluminescence immunoassay (Elecsys Modular Analytics E170, Roche diagnostics, Mannheim, Switzerland). Because two different insulin assays were used during the testing period those assessed using the AxSYM method had a correction factor of 0.81 applied to the insulin value (n=224). This correction factor was calculated by the laboratory staff and determined from a comparison of values for 31 samples assayed by each method. The inter-assay coefficient of variation ranged from 10.5 to 12.2% for the microparticle-enzyme immunoassay and 4.4 to 5.7% for the electrochemiluminescence immunoassay. Homeostasis model assessment (HOMA) index was used to estimate insulin resistance. HOMA was calculated using the equation (fasting glucose*fasting insulin)/22.5 (19).

The analytical laboratory met the criteria for precision and accuracy as specified for standardisation by the WHO Collaborating Centre for Reference and Research in Blood Lipids (Centers for Disease Control and Prevention, Atlanta, Georgia). Samples with unknown assigned values were included into each analytical run or immediately following calibration of the analyser. The inter-assay coefficient of variation ranged from 1.6 to 2.8% for total cholesterol, 3.2 to 5.4% for HDL cholesterol, 3.0 to 4.6%

for triglycerides, 2.0 to 2.4% for glucose and 4.4 to 12.2% for insulin. Duplicate samples were collected from the first participant scheduled for each clinic day (n=108) to examine measurement errors associated with collection, processing and analysis of blood samples. The technicians conducting the duplicate assays were blinded to the first run results. The coefficients of variation were 1.6% for total cholesterol, 2.8% for HDL cholesterol, 2.6% for triglycerides, 2.2% for glucose and 9.3% for insulin.

2.7 Derived variables

2.7.1 Continuous metabolic syndrome score

The metabolic syndrome is a combination of risk factors for CVD and type 2 diabetes. The International Diabetes Federation defines the metabolic syndrome as central adiposity (waist circumference ≥94cm for men and ≥80cm for women) plus any two of the following: raised triglycerides (>1.7mmol/L), or specific treatment for raised triglycerides; reduced HDL cholesterol (<0.9mmol/L for men or <1.1mmol/L for women), or specific treatment for reduced HDL cholesterol; raised blood pressure (systolic blood pressure ≥130mmHg or diastolic blood pressure ≥85mmHg) or treatment for hypertension; raised fasting plasma glucose (≥5.6mmol/L) or previous diagnosis of type 2 diabetes (20).

In this thesis, a continuous metabolic syndrome score was used to eliminate the need to dichotomise continuous outcomes and because cardio-metabolic risk increases progressively with increasing numbers of risk factors. Using methods described by Wijndaele et al (21) sex-specific principal component analysis with varimax rotation was applied to normalised International Diabetes Federation metabolic syndrome risk factors (20) to derive the principal components with eigenvalues ≥1.0. As in previous studies using this method, two principal components were identified: waist circumference, fasting triglycerides and HDL cholesterol; fasting glucose and blood pressure, that explained 34% and 26% of the variance in men and 31% and 25% of the variance in women, respectively. These principal component scores were summed and weighted according to the relative proportion of variance explained to compute the continuous metabolic score. A high score indicates an increased cardio-metabolic risk. It is important to note because the score was calculated using sex-specific principal component analysis the scores for men and women are not directly comparable.

2.7.2 Healthy lifestyle score

The healthy lifestyle score is an evidence-based simple assessment of health related lifestyle behaviours. The score is based on 10 healthy behaviours and characteristics and aligns with recommendations from peak bodies, such as the National Health and Medical Research Council in

Australia. Participants were given one point for each of the following criteria they met: BMI <25kg/m^2; eating ≥7 serves/day of vegetables and fruit; eating fish or seafood ≥2 times/week; eating red meat <5 times/week; regular use of skim milk; not adding salt to food; using margarine as a spread on savoury items; not smoking tobacco in the previous year; ≥3 hours/week moderate to vigorous physical activity; ≤20g alcohol/day (22). The points were summed to give a total score ranging from 0 to 10 healthy behaviours. The healthy lifestyle score has been shown to predict mortality in elderly men (23) and to be inversely associated with cardio-metabolic risk factors in young adults in the CDAH study (24).

2.8 Covariates

2.8.1 Demographics

Demographic variables were self-reported and obtained from the general questionnaire. Socio-economic status was estimated using information on education and occupation. The highest level of education was assessed using the question "What is the highest level of education you have completed?" and was collapsed into three categories for analysis: school only (primary school, Year 7, 8, or 9 or equivalent, Year 10 or equivalent, Year 11 or equivalent, Year 12 or equivalent), vocational (trade/apprenticeship, certificate/diploma), university (university degree, higher university degree).

Occupation was determined using the question "What is your main occupation NOW?" and gave examples for each of the categories. The answers were collapsed into four categories: professional/manager (manager or administrator, professional, associate professional), non-manual (tradesperson or related worker, advanced clerical or service worker, intermediate clerical, sales or service worker), manual (intermediate production or transport worker, elementary clerical, sales or service worker, labourer or related worker) and not in the workforce (no paid job). Because occupation was not a linear variable, a variable for employment status (employed versus not in the workforce) was created.

Marital status was determined using the question "What is your current marital status?" Response options were "single", "married", "de facto (living as married)", "separated/divorced", "widowed" and "other (please specify)". Parity was defined for women from the question "How many live births have you had?"

2.8.2 Smoking

Smoking status was classified as never, former or current smoker based on the two questions "Over your lifetime, have you smoked at least 100 cigarettes, or similar amount of tobacco?" and "How often do you now smoke cigarettes, cigars, pipes or any other tobacco products? Response options were “daily”, “at least once per week (but not daily)”, “less often than weekly” and “not at all”.

2.8.3 Physical activity and sedentary behaviour

International Physical Activity Questionnaire (IPAQ)

Physical activity was measured using the long version of the International Physical Activity Questionnaire (IPAQ) (25). The IPAQ assesses frequency, duration and intensity of physical activity. Participants were asked to report the number of days in the previous week they had done each activity for more than 10 minutes at a time, and how long they would usually spend doing each activity. The reliability and validity of the IPAQ has been tested in 12 countries including Australia (25). Test-retest repeatability was assessed within the same week and showed good reliability (pooled coefficient of 0.81). Comparison with accelerometer data showed comparative validity (pooled Spearmans coefficient of 0.33) (25). The leisure time physical activity (LTPA) domain was used in the analysis because it was more strongly associated with abdominal obesity than total physical activity.

Sedentary behaviour

Weekday and weekend sedentary behaviour over the previous week was also estimated. Participants reported the average amount of time they had spent sitting on weekdays and weekend days during the previous week. This question has been shown to have acceptable reproducibility (one week test-retest reliability intraclass correlation range of 0.74 to 0.89) and comparative validity (rank correlation with one week accelerometer counts range of 0.20 to 0.51) (25). In addition, participants reported total time spent watching television, videos or DVDs when it was the main activity they were doing. This question has also been shown to have acceptable reproducibility (one week test-retest intraclass correlation coefficient of 0.82) and comparative validity (rank correlation with three day sedentary behaviour log of 0.3) (26).

2.8.4 Alcohol intake

The frequency of consumption of nine alcoholic beverages from the FFQ and their average alcohol concentration (27) was used to estimate the number of standard drinks (10 grams of alcohol) consumed per week. Daily equivalents were calculated as shown in Table 2.3. Participants were classified as non-drinkers, drinkers who consume up to 14 drinks per week, or drinkers who consume more than 14 drinks per week. These groups are based on Australian alcohol guidelines for low-risk drinking (28).

2.9 Statistical analyses

The methods of statistical analysis are described in detail in each chapter. Where testing revealed a significant result and to discount the possibility that it may be due to inadequate control over type 1 error, adjustments were made for multiple comparisons using Bonferroni adjustments. Otherwise all analyses undertaken are reported, either in the text or presented in tables, to allow readers to perform their own adjustments if required, as advised by many authors (see for example Greenland and Rothman (29)). The analyses were not stratified by race because this information was not collected. However, the majority of the sample was Caucasian. In 1985, children were asked in which country their parents were born and only 6.3% reported that one or both of their parents were born in regions other than Australasia, North America, or Europe.

All analyses were conducted with STATA software (version 10.1, 2009, Statacorp, College Station, Texas).

2.10 Ethics

The ASHFS was approved by the State Directors General of Education and the CDAH study was approved by the Southern Tasmania Health and Medical Research Ethics Committee. Consent was required from both parent and child for the child to be included in the ASHFS. All CDAH participants gave informed written consent.

2.11 Summary

In 1985 8,498 7-15 year old children participated in the Australian Schools Health and Fitness Survey (ASHFS), a randomly selected nationally representative sample of Australian children. In 2002-2004, 6,840 of these participants were located, with 75.6% of those found agreeing to participate in the Childhood Determinants of Adult Health (CDAH) study. Data from the 2,868 individuals who completed the dietary questionnaire in 2004-2006, when they were 26-36 years old, were used in this thesis. The dietary questionnaire used in adulthood included a 127-item food frequency questionnaire, a food habits questionnaire and a meal patterns chart. Participants who attended study clinics (n=2,410) also had anthropometric measurements and gave a fasting blood sample.

2.12 References

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Appendix 2.A Differences in the food frequency questionnaires used in the 1995 National Nutrition Survey and the CDAH study

The FFQ used in the CDAH study was a slightly modified version of the one used in the 1995 National Nutrition Survey to reflect changes in the food supply. The ways in which the CDAH questionnaire was different are listed below in Table 2.A.1.

Table 2.A.1. Modifications made to the 1995 National Nutrition Survey FFQ for use in the CDAH study

Additional Items
Cream cheese (e.g. Philadelphia™)
Creamy dips and spreads
Decaffeinated coffee
Herbal tea
Medium strength beer
Fruits – dried, frozen, canned
Oatbran or wheatbran
Evening primrose oil/ fish oil
Herbal remedies e.g. Echinacae
The following foods were separated and included as individual line items:
Fresh and frozen fish
Mussels/oysters and lobster/crayfish/yabbies and calamari/squid and prawns
Almonds/walnuts/hazelnuts and cashews and coconut and peanuts and pistachio and seeds: pumpkin/sesame/pine nuts/ tahini
The following foods were combined into a one line item:
Mixed dishes with beef, veal, lamb, pork (e.g. casserole, stir fry)
Ham and bacon

Appendix 2.B Items from the food frequency questionnaire that were used to calculate the daily equivalents for each food group

Breads and cereals

White bread, toast or rolls

Wholemeal/mixed grain bread, toast or rolls

English muffin, bagel or crumpet

Flat bread (e.g. pita, chapatti)

Dry or savoury biscuits, crispbread, crackers

Muesli

Cooked porridge

Breakfast cereal

Rice (white or brown)

Pasta (including filled), noodles

Dairy

Milk as a drink

Flavoured milk drink (e.g. milkshake, iced coffee, hot chocolate)

Milk added to breakfast cereal

Yoghurt, plain or flavoured (including fromage frais)

Cheddar and other cheeses

Soy milk[a]

[a] The Australian Guide to Healthy Eating recommends soy milk as a dairy alternative if it is fortified with at least 100mg/100mL of calcium (1). Soy milk was included in the dairy group because in Australia the majority of soy milks are fortified with at least 120mg/100mL of calcium (for example 12/12 Sanitarium soy milk products (2), 13/14 Vitasoy milk products (3) and 2/3 Australia's Own Organic products (4)).

Lean meat and alternatives

Mince dishes (e.g. rissoles, meatloaf)[b]

Mixed dishes with beef, veal, lamb, pork (e.g. casserole, stir fry)[b]

Beef, veal – roast, chop or steak[b]

Lamb – roast, chop[b]

Pork – roast, chop[b]

Mixed dishes with chicken, duck, turkey (e.g. casserole, stir-fry)[b]

Chicken, turkey, duck – roast, steamed or barbequed[b]

Canned fish (e.g. tuna, salmon, sardines)

Fresh fish – steamed, baked, grilled

Frozen fish – steamed, baked, grilled

Mussels/oysters

Lobster/crayfish/yabbies

Calamari/squid

Prawns

Other seafood

Egg

Almonds, walnuts, hazelnuts

Cashews

Coconuts

Peanuts

Pistachio

Seeds – pumpkin, sesame, pine nuts, tahini

Other nuts, seeds

Baked beans

Other beans, lentils

[b] These items were only included as lean meat if participant indicated in the food habits questionnaire that fat was usually trimmed from their meat either before or after cooking.

Extra foods

Cream or sour cream

Ice cream

Cakes, sweet muffins, scones or pikelets

Sweet pies or sweet pastries

Other pudding or desserts

Plain, sweet biscuits

Cream, chocolate biscuits

Meat pie, sausage roll or other savoury pastries[c]

Pizza[c]

Hamburger[c]

Fried fish[c]

Hot chips, roast potatoes, potato wedges[c]

Chocolate (including chocolate bars e.g. Mars bar™)

Other confectionary

Potato chips, corn chips, Twisties™ etc

Oil and vinegar dressing

Mayonnaise or other creamy dressings

Jam, marmalade, syrup or honey

Creamy dips and spreads

Fruit juice drink or fruit cordial

Cordial

Soft drinks (including flavoured mineral water)

Light beer

Medium strength beer

Full strength beer

Red wine

White wine or champagne/sparkling wine

Wine cooler

Spirit-based mixed drinks (e.g. Lemon Ruski^{TM})

Sherry, port, fortified wines

Spirits, liquers

Other alcoholic drinks (e.g. cider)

[c] These items were not included in the “extra food” food group for the analyses examining associations between takeaway food consumption and dietary intake.

Note: Daily equivalents of fruits and vegetables were obtained from short questions in the food habits questionnaire.

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Appendix 2.C Comparison of CDAH participants with non-participants

As discussed in Chapter 2, the CDAH study is a follow-up of the ASHFS, which was a nationally representative sample of Australian children. However, only 5,170 of participants who were successfully traced enrolled in the CDAH study and 2,868 of those enrolled (33.7% of the original sample) completed the dietary questionnaire. In Table 2.C.1, socio-demographics, weight status and lifestyle variables are compared between CDAH participants and non-participants. Non-participants are separated into CDAH enrolled non-participants (CDAH enrolees who did not complete the dietary questionnaire) and ASHFS only (those who either did not want to participate in the CDAH study or who were unable to be traced). The adult variables are from the questionnaire that was completed during enrolment into the CDAH study. The enrolment questionnaire was expanded after the pilot trial for tracing participants. Therefore there is no adult data available for smoking status, self-reported weight and height or self-rated health for those who were enrolled into the study during the pilot trial in 2001 (n=284).

In childhood, compared to CDAH participants, a higher percentage of those who did not participate in the study were of low SES, did not eat before school, were overweight or obese, did not speak English at home and thought a good diet was of little or no importance. Those who enrolled in the CDAH study but did not participate had a higher percentage who were single, current smokers and rated their health as fair or poor compared to those who did participate in the study.

Table 2.C.1. Comparison of socio-demographics, weight status and lifestyle variables from childhood and adulthood for CDAH participants, CDAH enrolled non-participants and those who only participated in the ASHFS

Socio-demographic, weight status or lifestyle variable	CDAH participant[a] N=2868		CDAH enrolled non-participant[b] N=2303		ASHFS only[c] N=3327	
	n	%	n	%	n	%
Male	1280	44.6	1158	50.3	1869	56.2
Childhood variables						
SES quartile						
High	581	26.2	382	22.8	527	22.0
Med-high	638	28.7	437	26.1	725	30.2
Med-low	832	37.5	721	43.0	874	36.4
Low	170	7.7	137	8.2	275	11.5
BMI[d]						
Normal	2603	90.8	2020	87.7	2869	86.4
Overweight	233	8.1	242	10.5	386	11.6
Obese	31	1.1	41	1.8	67	2.0
Usually ate before school						
Yes	1945	86.1	1460	85.6	2021	83.4
No	315	13.9	246	14.4	403	16.6
Smoking experimentation						
No	1283	56.8	923	54.1	1354	55.7
Few puffs	542	24.0	403	23.6	579	22.6
<10 in life	165	7.3	121	7.1	180	7.4
>10 in life	269	11.9	260	15.2	346	14.2
Self-rated health						
Very good	826	36.5	616	36.0	834	34.3
Good	998	44.1	748	43.7	1044	42.9
Average	417	18.4	327	19.1	510	21.0
Poor	23	1.0	14	0.8	36	1.5
Very poor	0	0	5	0.3	9	0.4
Language spoken at home						
English	2019	89.3	1508	88.4	2048	84.4
Other	243	10.7	198	11.6	380	15.7
Importance of good diet						
High	1654	73.0	1246	73.0	1743	71.8
Some	494	21.8	354	20.7	496	20.4

Little	79	3.5	67	3.9	116	7.8
None	38	1.7	40	2.3	72	3.0
Adult variables						
Marital status						
Married or living as married	1693	59.3	1148	50.1	--	--
Single	1164	40.7	1143	49.9	--	--
Employed full-time						
Yes	883	31.0	767	33.6	--	--
No	1962	69.0	1514	66.4	--	--
BMI[e]						
Normal (<25kg/m^2)	1504	58.7	1147	56.5	--	--
Overweight (25-29.9kg/m^2)	774	30.2	619	30.5	--	--
Obese (≥30kg/m^2)	283	11.1	266	13.1	--	--
Current smoker						
Yes	483	18.5	736	34.8	--	--
No	2126	81.5	1378	65.2	--	--
Self-rated health						
Excellent	435	16.1	291	13.2	--	--
Very good	1115	41.2	825	37.5	--	--
Good	934	34.5	822	37.4	--	--
Fair	196	7.2	234	10.7	--	--
Poor	29	1.1	26	1.2	--	--

[a] CDAH participants – those who completed the dietary questionnaire.
[b] CDAH enrolled non-participants – CDAH enrolees who did not complete the dietary questionnaire.
[c] ASHFS only – those who either did not want to participate in the CDAH study or who were unable to be traced.
[d] Childhood BMI classified using Cole's cutoffs.
[e] Calculated from self-reported height and weight.
Note: due to missing data, numbers do not always equal the total sample size in the column heading.

Chapter 3. Involvement of young Australian adults in meal preparation: cross-sectional associations with socio-demographic factors and diet quality

3.1 Preface

Involvement in meal preparation has the potential to influence diet quality but this has not been thoroughly investigated. Little is known about the level of involvement young Australian adults have in preparing their meals and this is investigated in this chapter. The text from this chapter has been published in the Journal of the American Dietetic Association (1).

3.2 Introduction

Traditionally women have had the major responsibility for meal preparation for the household. A larger proportion of women are now in the workforce and recent Australian data show men have increased their contribution to food preparation and clean-up (2). Data from the United States of America (USA) from 1994-1996 suggested younger men (≤35 years) were more involved in meal preparation than older men (3). There has been little research into the socio-demographic and lifestyle factors associated with involvement in meal preparation.

The person responsible for preparing the main meal has the potential to affect the diet quality of the household because they can influence the quantities and types of foods consumed. The examination of meal preparation and its association with diet quality may be particularly important in early adulthood, since this is a transitional period where many individuals leave their parental home (4) and establish their own eating behaviors. Furthermore, due to increased partnering (5) and childbirth (4) during this time, there is potential for such behaviors to affect the diet of others. There is some evidence that greater involvement in meal preparation is associated with better diet quality in adolescents (6) and young adults (7). However, in the study of young adults, meal preparation was not measured directly but was a score consisting of potentially healthy diet practices such as preparing a green salad. The aims of this study were to describe the involvement of young adult men and women (aged 26-36 years) in preparing the main meal of the day; to determine the characteristics of young adults involved in meal preparation; and to investigate if level of involvement was associated with diet quality.

3.3 Methods

The Childhood Determinants of Adult Health (CDAH) study is a follow-up of children who participated in the 1985 Australian Schools Health and Fitness Survey, a nationally representative study of 7-15 year old children (8). The methods used have been described in detail elsewhere (9). Briefly, during 2001-2002 6,840 (80%) participants were successfully traced and 5,170 (61%) agreed to participate in the CDAH study. During 2004-2006 when the participants were 26-36 years old, self-administered questionnaires on socio-demographics, diet and lifestyle were posted to participants. The Southern Tasmania Health and Medical Research Ethics Committee approved the study. All participants gave informed written consent.

3.3.1 Dietary assessment

The person responsible for preparing the main meal was identified using the question "Who normally prepares your main meal at home on working days?" Response options were "I do not have meals at home on working days", "myself", "my partner", "my mother or father", "someone else (please specify)", "myself, together with (please specify)". For analysis the answers were collapsed into three groups: myself, shared (myself together with), and someone else (partner, parent, someone else).

Daily consumption of fruit and vegetables came from the two questions "How many serves of fruit do you usually eat each day?" and "How many serves of vegetables (excluding potatoes) do you usually eat each day?" Examples of serving sizes were given. Short questions are valid measures of fruit and vegetable intake (10).

A 127 item food frequency questionnaire (FFQ) was used to estimate dietary intake over the previous 12 months. There were nine response options ranging from "never/less than once per month" to "6+ times per day". The FFQ was a modified version of the one used in the 1995 National Nutrition Survey (11-15) and was based on an existing validated FFQ developed for Australian populations (16, 17). Daily equivalents were calculated for each item in the FFQ, assuming one serve was consumed at each eating occasion (12, 18). Missing values were given the value of zero (19).

The number of daily serves of breads and cereals, dairy, lean meat and alternatives (20), extra foods (foods that do not fit into the five core food groups (21)) and takeaway type foods (9) were calculated by summing the daily equivalents calculated from the FFQ (9). The dietary variables were treated as continuous variables and were not adjusted for energy intake because this was not available from the FFQ. Diet quality was assessed by comparing the mean number of daily serves from each food group by involvement in meal preparation.

3.3.2 Covariates

Self-reported demographic variables used in the analysis included age; marital status (married or living as married versus other); education (university, vocational, no post-secondary education); occupation (professional or manager, non-manual, manual and not in the workforce); full-time employment (yes or no), and parity (0, 1, 2, 3+). The long version of the International Physical Activity Questionnaire (22) was used to assess leisure time physical activity (LTPA) and time spent sitting. Time spent watching television was also assessed using a separate item (23).

3.3.3 Statistical analyses

Analyses were conducted separately for men and women. Chi square analysis was used to compare proportions of men and women involved in meal preparation. Multinomial tests of trends in proportions of categorical predictors were calculated using log multinomial regression (24). The P-value reported is the result of a test of the significance of the coefficient of a single categorical predictor. ANOVA was used to test for differences in means of the dietary data, that, if necessary, were transformed prior to analysis (for example by taking logarithms) to account for skewed distributions. The mean estimates were then back transformed for presentation in the tables. Covariates were considered as potential confounders if they were plausibly causally related to the outcome or were markers of other factors causally related to the outcome, and were not intermediate on the postulated pathway. Covariates considered included age, marital status, education, occupation, TV viewing (log transformed), and LTPA. Product terms were used to test for interactions, and change-in-coefficient methods were used to assess confounding using a 10% change in the parameter estimate as the criterion (25). All statistical analyses were conducted using STATA software (version 10.1, 2008, Statacorp, College Station, Texas).

3.4 Results and discussion

In total 2,881 participants (42% of those traced) answered the dietary questionnaire. Participants who did not answer the meal preparation question (n=22), and those who reported they did not eat their main meal at home (24 men and 21 women), were excluded from the analysis. The remaining 2,814 were included in the analysis of socio-demographic and lifestyle factors associated with meal preparation. Participants were excluded from the diet quality analysis if they answered less than 90% of the FFQ (n=95), or were pregnant (n=78, n=2,641 for analysis).

Although the 1985 sample was nationally representative only one third participated in the adult follow-up. Compared with the general Australian population of 25-34 year olds, this CDAH sample had a higher proportion who were married or living as married (men: 57% versus 67%, women: 64% versus 72% (4)), and a higher proportion employed as professionals or managers (men: 40% versus

57%, women: 38% versus 49% (26)). The proportion who were classified as overweight or obese (BMI ≥25kg/m^2) was very similar to that in the general population (men: 58% versus 62%, women: 35% versus 38% (27)). The mean age was 31.7 years for men and 31.5 years for women.

3.4.1 Involvement in meal preparation

More than twice as many women had sole responsibility for meal preparation than men (65% versus 29%, respectively; P<0.001. Table 3.1). This is similar to a previous study of 32-33 year olds from England during 2000-2001 where 72% of women and 37% of men reported being mainly responsible for preparing and cooking the food (28). In a nationally representative sample in the USA during 1994-1996 there was a trend for younger men (≤35 years) to be more involved in meal preparation; however, the proportion (34%) (3) was lower than in the current study where 54% of men had shared or sole responsibility. This difference may reflect temporal trends since the early 1990s, differences between countries, or differences in study design and measurement methods.

3.4.2 Factors associated with level of involvement in meal preparation

Participants were more likely to have sole responsibility for meal preparation if they were single compared with those who were married, as were women aged 34-36 years compared with younger women (Table 3.1). Participants were more likely to share responsibility for the meal preparation if they were married, had higher socio-economic status (SES, more educated or employed as professionals or managers) and more active compared with those who were single, lower SES and less active. In contrast, a previous study reported men from lower SES (lower income households) were more likely to be involved in the meal preparation (3) and another study reported no association with SES (7). The inconsistent findings may be due to the different measures of SES used, or differences in the socio-demographics of the study participants such as younger age (7) or a wider age range (3) and employment status. Additional analyses were undertaken with full-time employment, sitting time and parity as study factors. Men and women employed full-time less often took sole responsibility for meal preparation (P<0.001). Women were more likely to have shared responsibility if they were employed full-time (P<0.001), spent more time sitting (P=0.001) and had fewer children (P=0.005). Whereas women were more likely to have sole responsibility it they spent less time sitting (P<0.001) and had more children (P<0.001).

Table 3.1. Socio-demographic and lifestyle factors for involvement in meal preparation stratified by sex for Australian adults aged 26-36 years

Socio-demographic/lifestyle factor	Men				Women			
		Someone Else N=557	Shared N=336	Myself N=357		Someone Else N=177	Shared N=365	Myself N=1022
	n	%	%	%	n	%	%	%
Marital status								
Single	410	25.6	16.4	58.1	433	15.9	14.8	69.3
Married or living as married	840	53.8	32.0	14.2	1129	9.6	26.7	63.8
P-value			***P<0.001***[a]	***P<0.001***[b]			***P<0.001***[a]	***P=0.034***[b]
Age								
26-29 years	281	42.0	30.6	27.4	412	14.3	32.3	53.4
30-33 years	593	43.8	26.0	30.2	718	10.7	21.8	67.5
34-36 years	376	47.6	25.5	26.9	433	9.5	17.3	73.2
Linear trend			*P=0.171*[a]	*P=0.787*[b]			***P<0.001***[a]	***P<0.001***[b]
Education								
University	464	37.1	35.6	27.4	707	12.7	24.5	62.8
Vocational	449	49.0	23.2	27.8	406	11.3	24.6	64.0
No post-secondary education	333	49.0	20.1	30.9	448	9.2	20.5	70.3
Linear trend			***P<0.001***[a]	*P=0.282*[b]			*P=0.147*[a]	***P=-0.010***[b]

Occupation								
Professional or manager	705	41.8	30.1	28.1	746	14.3	27.4	58.3
Non-manual	91	38.5	25.3	36.3	407	11.3	22.6	66.1
Manual	392	52.6	21.9	25.5	79	10.1	20.3	69.6
Not in the workforce	45	26.7	26.7	46.7	303	4.6	14.9	80.5
P-value			***P=0.007***[a]	*P=0.622*[b]			***P<0.001***[a]	***P<0.001***[b]
TV viewing								
<8 hours/week	305	39.7	29.8	30.5	523	11.5	27.2	61.4
8-14 hours/week	354	46.1	30.8	23.2	499	11.0	20.8	68.1
15-21 hours/week	270	45.2	24.8	30.0	276	10.1	21.4	68.5
>21 hours/week	205	48.3	18.5	33.2	171	14.0	20.5	65.5
Linear trend			***P=0.002***[a]	*P=0.291*[b]			***P=0.038***[a]	*P=0.108*[b]
Leisure time physical activity								
≤1.0 hour/week	480	50.0	22.5	27.5	621	10.6	22.4	67.0
1.1-3.0 hours/week	281	42.7	28.1	29.2	411	11.7	21.4	66.9
3.1-5.0 hours/week	167	37.1	34.1	28.7	241	14.5	24.9	60.6
>5.0 hours/week	215	39.5	29.3	31.2	212	9.4	27.4	63.2
Linear trend			***P=0.012***[a]	*P=0.358*[b]			*P=0.106*[a]	*P=0.107*[b]

[a] The P-values reported are a test of difference or trend in the proportions who share responsibility for meal preparation at each level of the study factor.
[b] The P-values reported are a test of difference or trend in the proportions who have sole responsibility for meal preparation at each level of the study factor.

3.4.3 Diet quality

A higher level of involvement in meal preparation was not consistently associated with higher diet quality (Table 3.2). Men who had sole responsibility for meal preparation ate significantly more lean meat and alternatives, while men who had someone else preparing their food ate significantly more extra foods. After adjusting for age, education and LTPA only the association with lean meats remained significant. This difference was not due to a higher intake of all meat. Additional analysis showed daily consumption of high fat meats did not differ between the three groups (mean (SD): someone else 0.89 (0.78); shared 0.78 (0.74); myself 0.78 (0.66); P=0.145). Although men who had sole responsibility for meal preparation had a higher intake of lean meat and alternatives, all three of the meal preparation groups had a mean intake above the recommendation for Australian adults of one serve per day (21). Women who shared the meal preparation ate significantly more vegetables and dairy after adjusting for age and TV viewing. Additional (post-hoc) analysis was conducted to examine which components of the dairy food group women who shared the cooking were consuming more of, to ensure it was not high-fat items such as cheese. The difference was mainly due to a higher intake of soy beverages in women who shared the cooking (mean (SD): someone else 0.10 (0.29); shared 0.18 (0.54); myself 0.10 (0.38); P=0.011).

There was no association between level of involvement in meal preparation and consumption of takeaway type foods for men or women. Researchers from a previous study in 18-23 year olds reported that participants involved in food preparation consumed less fast food and more often met dietary recommendations for fat, calcium, fruit, vegetables and whole-grains (7). However, in that study, meal preparation was not measured directly, but was a score calculated from how often participants engaged in five different behaviors over the previous 12 months. The behaviors included potentially healthy diet practices such as preparing a green salad, buying fresh vegetables and preparing a dinner with chicken, fish or vegetables.

Table 3.2. Mean (SD) number of daily serves for each food group and takeaway type foods by who prepares the main meal stratified by sex for Australian adults aged 26-36 years

	Someone Else		Shared		Myself			Adjusted
Food Group	Mean	SD[a]	Mean	SD	Mean	SD	P-value[b]	P-value[c]
Men	N=540		N=330		N=341			
Breads and cereals	2.70	1.33	2.68	1.19	2.59	1.46	0.232	0.118
Fruit	1.29	0.56	1.33	0.57	1.28	0.55	0.754	0.648
Vegetables[d]	1.49	0.62	1.65	0.63	1.45	0.65	0.088	0.253
Dairy	1.56	1.04	1.71	1.08	1.51	1.21	0.277	0.352
Lean meat and alternatives	1.61	1.02	1.64	0.88	1.75	1.19	**0.012**	**0.005**
Extra Foods	6.30	2.71	5.73	2.22	5.74	2.85	**0.006**	0.109
Takeaway type foods[e]	0.21	0.42	0.11	0.26	0.20	0.41	0.058	0.409
Women	N=162		N=331		N=937			
Breads and cereals	2.54	1.27	2.63	1.20	2.61	1.27	0.747	0.732
Fruit	1.38	0.61	1.49	0.63	1.37	0.58	0.165	0.140
Vegetables[d]	1.60	0.62	1.91	0.65	1.79	0.68	**<0.001**	**<0.001**
Dairy	1.49	1.00	1.70	1.04	1.52	1.08	**0.043**	**0.043**
Lean meat and alternatives	1.95	1.00	1.99	1.11	1.90	1.06	0.278	0.291
Extra Foods	4.86	1.92	4.49	1.93	4.62	1.99	0.420	0.639
Takeaway type foods[e]	0.02	0.07	0.01	0.03	0.02	0.04	0.296	0.414

[a] SD, standard deviation
[b] Statistical P-value for differences in means, calculated using ANOVA
[c] Analyses for men adjusted for age, education, and leisure time physical activity; analyses for women adjusted for age, and (log transformed) TV viewing.
[d] The vegetables food group excludes potatoes.
[e] Takeaway type foods include hamburgers, pizza, hot chips/roast potatoes/potato wedges, fried fish, meat pies/sausage rolls/other savory pastries.
Note: Some people did not answer the fruit and vegetable questions. Men: who share n=327 for fruit, n=328 for vegetables; myself n=340 for fruit and for vegetables. Women: who share n=330 for fruit; myself n=936 for vegetables.

Strengths of this study include the large sample and the focus on young adults. The latter being important because this is a generation in which a larger proportion of men have become involved in meal preparation (3). There are also several limitations with the present study's findings. The sample is not truly nationally representative, and this may limit the generalisability of the prevalence estimates. While there is no reason to doubt that our meal preparation measure correctly classified the majority of the participants, when participants reported that they shared this task the extent to which they shared the responsibility was not able to be established. In addition, no definition of meal preparation was provided. For some participants meal preparation may involve making meals from raw ingredients whereas for others it may only involve heating frozen or ready-to-eat meals. Components of mixed dishes are generally difficult to assess using FFQs (29), and were not included as items in the food groups which may result in underestimated intakes for some food groups.

3.5 Conclusion

In this sample of young adults, it was women who predominantly had sole responsibility for preparing the main meal. However, more than half of the men reported they shared or had full responsibility. Sharing responsibility for meal preparation was associated with higher intakes of vegetables and dairy foods for women but these improvements in diet quality were small and there were no benefits with taking sole responsibility. These results suggest that strategies seeking to motivate greater involvement in meal preparation may not be sufficient to markedly improve diet quality in young Australian adults.

3.6 Postscript

The results of this chapter showed that involvement in meal preparation was not strongly associated with diet quality but was associated with some aspects of diet. Whether involvement in meal preparation is associated with BMI or abdominal obesity is examined in Chapter 4.

3.7 References

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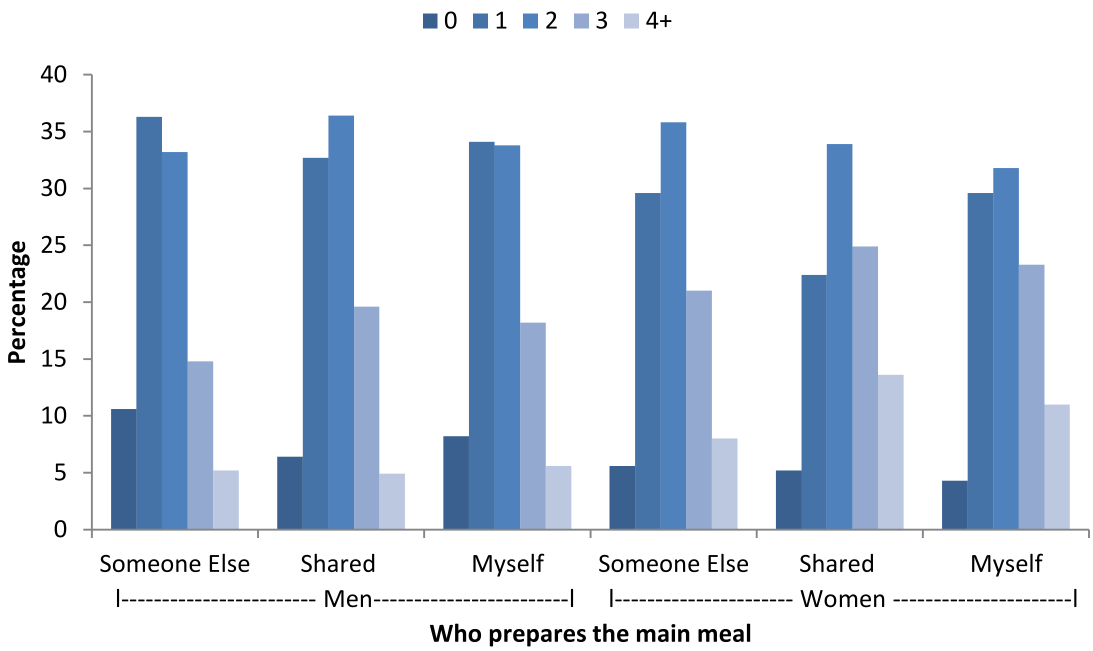
Appendix 3.A Number of dietary guidelines achieved

Chi-square analyses were used to compare the percentage of participants achieving each number of dietary guidelines by level of involvement in meal preparation (Figure 3.A.1). The results were P=0.359 for men and P=0.249 for women. This suggests level of involvement in meal preparation is not associated with overall diet quality for men or women.

Figure 3.A.1. Percentage of men and women achieving each number of dietary guidelines by level of involvement in meal preparation



Men: someone else n=540, shared n=327, myself n=340. Women: someone else n=162, shared n=330, myself n=935.
See Section 2.4.3 for the dietary recommendations for Australian adults.

Chapter 4. Involvement of young Australian adults in meal preparation: cross-sectional associations with abdominal obesity and body mass index

4.1 Preface

The research in the previous chapter examined associations between involvement in meal preparation and diet quality. Although the associations were not strong, involvement in meal preparation was associated with some aspects of diet quality. The research presented in this chapter examines whether involvement in meal preparation is associated with overweight and obesity. The text from this chapter has been published in the Journal of the American Dietetic Association.

4.2 Introduction

With the rapid increase in the prevalence of obesity in recent decades there has been interest in examining the socio-ecological determinants of overweight and obesity at the environmental, social and individual levels. One possible individual or social determinant of overweight and obesity that had not been well examined is involvement in meal preparation. Women have traditionally been responsible for purchasing and preparing the food for the household. However, a larger proportion of women are now in the workforce and recent data show that men have increased the amount of time they spend doing domestic chores (1). In a national sample of young Australian adults it was recently reported that women predominantly had sole responsibility for preparing the main meal (2). However, more than half of the men were also involved with either shared or sole responsibility (2). Data collected for the 1994 Continuing Survey of Food Intakes of Individuals in United States of America suggest that younger men are more involved in meal preparation than older men (34% of men aged 35 years or younger compared with 17% of men aged 56 years or older) (3).

The person responsible for meal preparation has the potential to influence dietary intake and weight status of the household because they can influence the types and amounts of foods consumed. However, there are very few studies examining this. Previous studies examining involvement in food purchasing and preparation have shown associations with diet quality in adolescents (4) and young adults (5). A study of 4,746 11-18 year olds, reported higher involvement in meal preparation was associated with higher vegetable (females only) and fruit consumption, and lower consumption of soft drinks (4). Similarly, 18-23 year olds who were more involved in meal preparation were more likely to meet dietary objectives for fruit, vegetables and whole grains and had a lower intake of fast food compared with those with low involvement (5). High intakes of fast food and energy containing drinks and low intakes of fruits, vegetables and whole grain products have been shown to be associated with being overweight or obese (6). Although level of involvement in meal preparation has been shown to be associated with better diet quality, it is unclear whether there is a link between involvement in meal preparation and being overweight or obese. Only one previous study has examined this issue and it was reported that involvement in meal preparation was not associated with body mass index (BMI). However, these results were limited by the use of self-reported height and body weight to calculate BMI (5). No previous studies have examined associations between level of involvement in meal preparation and abdominal obesity. Abdominal obesity is thought to be a better indicator of CVD and type 2 diabetes risk than BMI (7, 8) as fat distributed around the waist is more harmful than overall obesity.

In the Childhood Determinants of Adult Health (CDAH) study, a national sample of young Australian adults, it has previously been shown that women who shared the meal preparation had slightly higher intakes of vegetables and dairy products, and men who had sole responsibility had higher intakes of lean meat and alternatives (2). In the CDAH sample overweight and obesity has been shown to be associated with eating takeaway food more than once per week (9) and being obese as a child (10). The aim of this paper was to investigate whether the level of involvement in meal preparation is associated with objectively measured BMI and abdominal obesity in young adults aged 26-36 years in the CDAH study.

4.3 Methods

The CDAH study is a follow-up of children who participated in the 1985 Australian Schools Health and Fitness Survey, a nationally representative study of 7-15 year old children (11). The sampling methods used have been described in detail elsewhere (9). Briefly, the first stage of sampling involved selecting schools with a probability proportional to student enrolment (school participation rate 90.1%). The second stage involved simple random sampling within each age and sex category to select children within those schools (child participation rate 67.5%). During 2001-2002, 6,840 (80%) participants were successfully traced and 5,170 (61%) agreed to participate in the CDAH study. Thirty-four clinics were held in every state and territory around Australia during 2004-2006 when the participants were 26-36 years old. The clinics included anthropometric measurements. Questionnaires on demographics, diet, food habits and physical activity were posted to participants two weeks before their clinic appointment. Participants were asked to bring their completed questionnaires with them to the clinic. The Southern Tasmania Health and Medical Research Ethics Committee approved the study. All participants gave informed written consent.

4.3.1 Involvement in meal preparation

As part of the questionnaire concerning food habits, respondents were asked "Who normally prepares your main meal at home on working days?" Response options were "I do not have meals at home on working days", "myself", "my partner", "my mother or father", "someone else (please specify)", "myself, together with (please specify)". For analysis the answers were collapsed into three groups: myself, shared (myself together with), and someone else (partner, parent, someone else).

4.3.2 Anthropometric measurements

All anthropometric measurements were taken following standardised protocols and the staff were trained by the same qualified anthropometrist. In total, seven staff took the anthropometric measurements. Halfway through the clinics in every state, the trainer attended the clinics to check technique. Participants were standing, without shoes and were wearing light clothing. Waist circumference was measured at the narrowest point between the lower costal border and the iliac crest at the end of normal expiration. Measurements were taken using a Lufkin steel (non-stretch) tape measure and were recorded to the nearest 0.5cm. Three measurements were taken and the mean value was used in the analysis. Moderate abdominal obesity was defined as waist circumference ≥94cm for men and ≥80cm for women (12). Body weight was measured using a portable digital scale (Heine, Dover, USA) and height was measured using a portable stadiometer (Invicta, Leicester, UK). BMI was calculated using the formula weight (kg) divided by height (m) squared and overweight was defined as BMI ≥25kg/m^2.

4.3.3 Covariates

Demographic variables used in the analysis included age, marital status (married or living as married versus other), education (university, vocational, no post-secondary education), occupation (professional or manager, non-manual, manual, not in the workforce), and parity (0, 1, 2, 3+). The long version of the International Physical Activity Questionnaire was used to assess physical activity (13). The leisure time physical activity (LTPA) domain was used in the analysis because it was more strongly correlated with abdominal obesity than total physical activity. Time spent watching TV was assessed using a separate item (14). Dietary intake was assessed using a 127 item food frequency questionnaire (15) and short questions on usual fruit, vegetable and takeaway food consumption (9). The number of daily servings of breads and cereals, dairy, lean meat and alternatives and extra foods (foods that do not fit into the five core food groups) were calculated by summing the daily equivalents calculated from the food frequency questionnaire (9). Daily fruit and vegetable consumption was assessed using the two short questions "How many serves of fruit do you usually eat each day?" and "How many serves of vegetables (excluding potatoes) do you usually eat each day?" (16).

4.3.4 Statistical analyses

All statistical analyses were conducted separately for men and women. Log binomial regression was used to compare proportions of overweight and obese participants classified by their level of involvement in meal preparation. Covariates were added that plausibly were causally related to the outcome or were markers of other factors causally related to the outcome, and were not intermediate on the postulated pathway. Covariates included age, marital status, education, occupation, TV viewing, LTPA and parity. TV viewing was log-transformed to remove right skewness. Product terms were used to test for interactions, and change-in-coefficient methods were used to assess confounding using a 10% change in the parameter estimate as the criterion (17). The models were adjusted for age, education and LTPA for men; and age and (log-transformed) TV viewing for women. Dietary variables previously shown to be significantly different between the meal preparation groups in this sample (2) were added to the model to see if any differences were mediated through dietary intake. These dietary variables were lean meat and alternatives and extra foods for men, and vegetables and dairy for women. Statistical analyses were conducted using STATA software (version 10.1, 2008, Statacorp, College Station, Texas).

4.4 Results and discussion

In total, 2,197 participants (91% of those who participated in the follow-up) answered the meal preparation question and had anthropometric measurements. Participants who reported they did not eat their main meal at home (n=36), were missing data for at least one of the covariates included in the model (n=158) and pregnant women (n=7) were excluded from the analysis (n=1,996 for analysis).

The 1985 sample was nationally representative and one third participated in the adult follow-up. Compared with the general Australian population of 25-34 year olds, the CDAH sample at follow-up had a higher proportion who were married or living as married (men: 57% versus 67%, women: 64% versus 68% (18)), and a higher proportion of professionals or managers (men: 40% versus 61%, women: 38% versus 52% (19)). The proportion who had a BMI ≥25kg/m^2 was very similar to the general population (men: 58% versus 62%, women: 35% versus 39% (20)). The mean age was 31.6 years for men and 31.4 years for women (Table 4.1).

Table 4.1. Socio-demographic and lifestyle factors for who prepares the main meal at home on working days for Australian men and women aged 26-36 years

Socio-demographic/lifestyle factor	Men[a]						Women[b]					
	Someone Else		Shared		Myself		Someone Else		Shared		Myself	
	N=425		N=257		N=266		N=128		N=241		N=679	
Age (mean, SD)	31.8	2.5	31.3	2.6	31.5	2.5	30.6	2.6	30.8	2.6	31.7	2.6
Marital status (%, n)												
Single	25.5	78	18.3	56	56.2	172	17.5	59	15.4	52	67.2	227
Married or living as married	54.1	347	31.3	201	14.6	94	9.7	69	26.6	189	63.7	452
Education (%, n)												
University	37.0	139	37.2	140	25.8	97	12.9	66	25.5	131	61.6	316
Vocational	50.6	172	21.8	74	27.7	94	13.3	34	21.1	54	65.6	168
No post-secondary education	49.1	114	18.5	43	32.3	75	10.0	28	20.1	56	69.9	195
Occupation (%, n)												
Professional or manager	42.3	235	30.5	169	27.2	151	14.4	77	27.5	147	58.1	310
Non-manual	40.9	29	22.5	16	36.6	26	12.3	34	21.0	58	66.7	184
Manual	52.0	144	21.7	60	26.4	73	10.6	5	17.0	8	72.3	34
Not in workforce	32.3	10	29.0	9	38.7	12	6.2	11	12.4	22	81.5	145
Leisure time physical activity (mean, SD)												
Hours/week	159.2	207.3	204.1	235.2	172.5	201.6	149.8	158.3	175.4	194.7	149.5	173.6
TV viewing (geometric mean, SD)												
Hours/week	11.9	13.5	10.5	10.7	11.1	15.1	10.5	10.5	8.3	9.9	9.9	10.9

Parity (%, n)												
0	-	-	-	-	-	-	12.5	13	28.9	30	58.7	61
1	-	-	-	-	-	-	13.3	23	16.8	29	69.9	121
2	-	-	-	-	-	-	7.5	18	18.8	45	73.8	177
3+	-	-	-	-	-	-	2.9	3	16.4	17	80.8	84

SD, standard deviation

[a] Due to some missing data numbers do not always add up to 948 for men.

[b] Due to some missing data numbers do not always add up to 1,048 for women.

For men, sharing the meal preparation was associated with a reduced prevalence of abdominal obesity after adjusting for age, education and LTPA (Table 4.2). Additional adjustments for indicators of diet quality did not diminish this association (PR: 0.92; 95% CI: 0.86, 0.99). There were no associations between abdominal obesity and having sole responsibility for the meal preparation. Involvement in meal preparation was not associated with BMI. In this sample of young adults, sharing the meal preparation has previously been reported to be associated with being married, university educated, employed as professionals or managers, and being physically active (2). The analysis in the current study adjusts for education and LTPA. Marital status, occupation and TV viewing were not included in the models as they did not satisfy the criteria for being confounders. There was no evidence that the association between shared meal preparation and abdominal obesity was mediated through diet quality (2). However, the findings may be due to differences in energy intake as a result of smaller portion sizes because the food frequency questionnaire used to measure dietary intake only assessed frequency of consumption. Although energy intake was not measured, the analysis was stratified by sex and adjusted for age and physical activity, which would have partially accounted for energy intake.

For women, after adjusting for age and time spent watching TV, the level of involvement in meal preparation was not significantly associated with abdominal obesity or BMI. These non-statistically significant findings are similar to a previous study of young adults reporting no association between meal preparation and BMI when using self-reported height and weight (5).

Involvement in meal preparation was not strongly associated with weight status. It is likely that health promotions that target reducing intakes of fast food and sugary beverages and increasing consumption of fruit and vegetables and a healthy breakfast (21) would be more beneficial in preventing the development of overweight and obesity.

Table 4.2. Prevalence ratios for abdominal obesity and BMI ≥25kg/m^2 by who prepares the main meal for Australian men and women aged 26-36 years

				Unadjusted		Adjusted[a]	
Obesity Measure	n	N	%	PR	95% CI	PR	95% CI
Men							
Waist circumference ≥94cm[c]							
Someone else	132	425	31.1	1.00		1.00	
Shared	51	257	19.8	**0.89**	**0.83, 0.96**	**0.92**	**0.86, 0.99**
Myself	78	266	29.3	0.98	0.92, 1.05	0.99	0.92, 1.06
BMI ≥25kg/m^2[c]							
Someone else	266	425	62.6	1.00		1.00	
Shared	154	257	59.9	0.97	0.90, 1.05	0.99	0.92, 1.07
Myself	159	266	59.8	0.97	0.90, 1.05	0.98	0.91, 1.05
Women							
Waist circumference ≥80cm[c]							
Someone else	51	128	39.8	1.00		1.00	
Shared	73	241	30.3	0.91	0.82, 1.01	0.93	0.84, 1.03
Myself	238	679	35.1	0.95	0.87, 1.04	0.94	0.86, 1.03
BMI ≥25kg/m^2[c]							
Someone else	57	128	44.5	1.00		1.00	
Shared	86	241	35.7	0.92	0.82, 1.02	0.93	0.84, 1.04
Myself	261	679	38.4	0.94	0.86, 1.03	0.93	0.85, 1.02

n, number of participants with abdominal obesity or BMI ≥25kg/m^2. N, total number of participants in each meal preparation group. PR, prevalence ratio, calculated using log binomial regression.
[a] Analyses for men were adjusted for age, education and leisure time physical activity.
[b] Analyses for women were adjusted for age and (log-transformed) TV viewing.
[c] Cut points were defined using the World Health Organization classifications (12).

There are several limitations with the present study's findings. The sample is not truly nationally representative, and this may limit the generalisability of the prevalence estimates. No definition of meal preparation was given, therefore meal preparation was defined by the participant and may range from heating a frozen or ready-to-eat meal to preparing a meal from raw ingredients. In addition, when participants reported that they shared the meal preparation the extent to which they shared the responsibility was not established. Only involvement in meal preparation on weekdays was examined and level of involvement may be different on weekend days. These analyses were cross-sectional so it is uncertain whether the involvement in meal preparation reported here reflected established patterns. Because overweight and obesity develop over a period of time, longitudinal studies are needed to determine if involvement in meal preparation predicts incident overweight and obesity. Strengths of this study include the large population-based sample of young adults and using trained staff following standardised protocols to take the anthropometric measurements.

4.5 Conclusion

This was the first study to examine associations between level of involvement in meal preparation and objectively measured weight status. In this sample of young adults, involvement in meal preparation was not strongly associated with weight status.

4.6 Postscript

The results from Chapter 3 and Chapter 4 showed that involvement in meal preparation was not strongly associated with diet quality or abdominal obesity. Preliminary analyses suggested no significant associations between involvement in meal preparation and biochemical cardio-metabolic risk factors. Therefore further analyses were not pursued. However, associations between diet quality and meal preparation may be influenced by the availability of food in the household. Therefore, associations between involvement in food purchasing and diet quality and weight status were also examined and these results are presented in Appendix 4.A.

4.7 References

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Appendix 4.A Involvement in food purchasing: are there cross-sectional associations with diet quality and weight status in young adults?

4.A.1 Background

The previous two chapters found involvement in preparing the main meal was not strongly associated with diet quality or being overweight or obese. It is possible that involvement in purchasing the groceries may be a more strongly associated with diet quality and weight status because whoever purchases the food determines what food items are available for meals and snacks that are prepared at home. This appendix examines associations between involvement in purchasing the groceries with diet quality, waist circumference and BMI.

The person responsible for purchasing the food was identified using the question: “Who normally buys the groceries for your household?” The response options were “nobody”, “myself”, “my partner”, “my mother or father”, “someone else (please specify)”, “myself, together with (please specify)”. For the analyses, the responses were collapsed into three groups: myself, shared (myself together with), and someone else (my partner, my mother or father, someone else). The statistical analyses used were the same as for level of involvement in meal preparation (Chapter 3 and Chapter 4). Participants who reported “nobody normally brought the groceries” (n=3) were excluded from the analyses that examined associations between SES and lifestyle factors, diet quality and weight status.

4.A.2 Results

Significantly more women than men were responsible for purchasing the food (Table 4.A.1). Most commonly, the participant’s partner was the other individual involved when the food purchasing was shared.

Socio-demographic and lifestyle factors

The prevalence of shared purchasing was higher among participants who were married or living as married, of younger age, more highly educated, and employed in professional or managerial positions (Table 4.A.2). Additionally, shared purchasing was more common among men who spent more time doing leisure time physical activity and among women who were employed full time, spent more time sitting and had fewer children. Sole responsibility for food purchasing was more common among men who were single, or not employed full time, and among women who were older, or not employed in professional or managerial positions, spent less time sitting or had more children.

Table 4.A.1. Who normally buys the groceries for men and women

	Men (N=1273)		Women (N=1585)	
Person responsible	n	%	n	%
Myself	311	24.4	1074	67.7
Shared[a]	440	34.6	395	24.9
Partner	404		349	
Parent	12		17	
Housemate	24		20	
Other family member	8		15	
Someone Else[a]	522	41.0	113	7.1
Partner	426		56	
Parent	84		50	
Housemate	5		1	
Other	5		6	
Nobody	0	0	3	0.2

Chi-square test of difference by sex in the proportions of participants in each of the four categories of involvement in food purchasing (P<0.001).
[a] The numbers in the subgroups do not equal the total because multiple options were allowed and some people did not specify the other person involved.

Table 4.A.2. Socio-demographic and lifestyle factors for involvement in purchasing the groceries stratified by sex for Australian men and women aged 26-36 years

Socio-demographic/lifestyle factor	Men						Women					
	Someone Else		Shared		Myself		Someone Else		Shared		Myself	
	n	%	n	%	n	%	n	%	n	%	n	%
Marital status												
Single	102	24.9	80	19.6	227	55.5	55	12.7	85	19.7	292	67.6
Married or living as married	408	48.6	355	42.3	77	9.2	57	5.1	302	26.8	770	68.2
P-Value				***P<0.001***[a]		***P<0.001***[b]				***P=0.005***[a]		*P=0.815*[b]
Age												
26-29 years	101	36.0	116	41.4	63	22.5	51	12.4	141	34.2	220	53.4
30-33 years	229	38.6	208	35.1	156	26.3	36	5.0	173	24.1	509	70.9
34-36 years	180	48.9	111	29.5	85	22.6	25	5.8	74	17.1	334	77.1
Linear trend				***P=0.002***[a]		*P=0.903*[b]				***P<0.001***[a]		***P<0.001***[b]
Education												
University	147	31.7	196	42.2	121	26.1	54	7.7	203	28.8	449	63.6
Vocational	209	46.6	135	30.1	105	23.4	34	8.4	94	22.9	279	68.7
School only	153	46.1	103	31.0	76	22.9	23	5.1	91	20.3	334	74.6
Linear trend				***P<0.001***[a]		*P=0.265*[b]				***P=0.001***[a]		***P<0.001***[b]
Occupation												
Professional or manager	256	36.3	276	39.2	173	24.5	63	8.5	232	31.1	450	60.4
Non-manual	32	35.6	32	35.6	26	28.9	29	7.1	90	21.9	289	71.0
Manual	199	50.8	110	28.1	83	21.2	6	7.6	13	16.5	60	76.0
Not in workforce	15	33.3	11	24.4	19	42.2	13	4.3	46	15.2	244	80.5
Linear trend				***P<0.001***[a]		*P=0.868*[b]				***P<0.001***[a]		***P<0.001***[b]

Employment												
Not employed full time	44	33.3	37	28.0	51	38.6	34	4.2	140	17.1	643	78.7
Employed full time	466	41.7	398	35.6	253	22.7	78	10.5	248	33.2	420	56.3
P-Value				*P=0.098*[a]		***P<0.001***[b]				***P<0.001***[a]		***P<0.001***[b]
TV viewing												
<8 hours/week	113	37.1	105	34.4	87	28.5	44	8.4	133	25.5	345	66.4
8-14 hours/week	146	41.4	141	39.9	66	18.7	35	7.0	112	22.4	352	70.5
15-21 hours/week	112	41.5	96	35.6	62	23.0	15	5.4	74	26.8	187	67.8
>21 hours/week	97	47.3	53	25.9	55	26.8	12	7.0	49	28.7	110	64.3
Linear trend				***P=0.048***[a]		*P=0.775*[b]				*P=0.387*[a]		*P=0.873*[b]
Sitting												
<20 hours/week	89	43.4	73	35.6	43	21.0	11	3.6	48	15.8	245	80.6
20-40 hours/week	175	43.3	125	30.9	104	25.7	33	5.8	139	24.3	401	70.0
41-60 hours/week	116	37.5	124	40.1	69	22.3	39	10.5	109	29.4	223	60.1
>60 hours/week	86	39.5	75	34.4	57	26.2	21	9.7	68	31.5	127	58.8
Linear trend				*P=0.445*[a]		*P=0.298*[b]				***P<0.001***[a]		***P<0.001***[b]
Leisure time physical activity												
≤1.0 hour/week	227	47.3	146	30.4	107	22.3	50	8.1	148	23.8	423	68.1
1.1-3.0 hours/week	111	39.5	97	34.5	73	26.1	26	6.3	106	25.8	279	67.8
3.1-5.0 hours/week	53	31.7	74	44.3	40	24.0	17	7.1	64	26.7	159	66.3
>5.0 hours/week	78	36.5	81	37.9	55	25.7	13	6.1	55	25.9	144	67.9
Linear trend				***P=0.007***[a]		*P=0.365*[b]				*P=0.403*[a]		*P=0.795*[b]

Parity												
0	--	--	--	**--**	--	--	12	8.3	47	32.6	85	59.0
1	--	--	--	**--**	--	--	15	6.9	35	16.2	166	77.9
2	--	--	--	**--**	--	--	16	5.9	33	12.2	221	81.9
3+	--	--	--	**--**	--	--	3	1.8	21	18.8	89	79.5
Linear trend										***P<0.001[a]***		***P<0.001[b]***

[a] The P-values reported are a test of difference or trend in the proportions who share responsibility for purchasing the groceries at each level of the study factor.

[b] The P-values reported are a test of difference or trend in the proportions who have sole responsibility for purchasing the groceries at each level of the study factor.

Diet quality

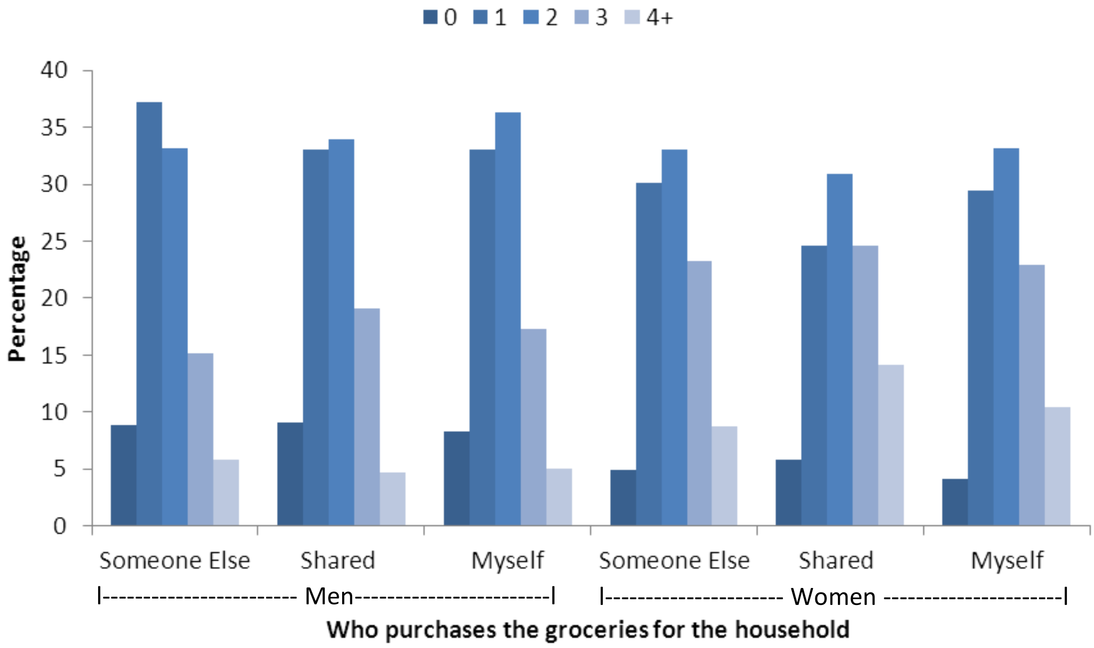
Significant associations between dietary intake and involvement in purchasing the food were observed only in men (Table 4.A.3). Men who had sole responsibility for purchasing the food ate significantly more lean meat and alternatives, while men who had someone else purchasing their food ate significantly more extra foods. Only the association with extra foods remained statistically significant after adjusting for age and education. Level of involvement in purchasing the groceries was not associated with overall diet quality for men (P=0.770) or for women (P=0.387, Figure 4.A.1).

Table 4.A.3. Mean (SD) number of daily serves from each food group and weekly intake of takeaway type foods by who purchases the groceries

	Someone Else		Shared		Myself			Adjusted
Food Group	Mean	(SD)	Mean	(SD)	Mean	(SD)	P-value	P-value [a]
Men	N=505		N=431		N=300			
Breads and cereals	2.70	(1.42)	2.65	(1.21)	2.64	(1.37)	0.830	0.342
Fruit	1.30	(0.57)	1.34	(0.59)	1.24	(0.49)	0.358	0.349
Vegetables[b]	1.51	(0.67)	1.62	(0.61)	1.41	(0.61)	0.067	0.176
Dairy	1.59	(1.08)	1.62	(1.02)	1.54	(1.23)	0.916	0.649
Lean meat and alternatives	1.59	(1.02)	1.67	(0.97)	1.72	(1.16)	**0.113**	**0.120**
Extra foods	6.24	(2.72)	5.86	(2.29)	5.74	(2.91)	**0.009**	**0.039**
Takeaway type foods[c]	0.20	(0.41)	0.11	(0.27)	0.23	(0.46)	0.028	0.214
Women	N=103		N=363		N=980			
Breads and cereals	2.52	(1.30)	2.62	(1.29)	2.62	(1.23)	0.748	0.957
Fruit	1.36	(0.58)	1.48	(0.64)	1.37	(0.57)	0.158	0.101
Vegetables[b]	1.71	(0.64)	1.86	(0.67)	1.78	(0.68)	0.104	0.070
Dairy	1.31	(1.07)	1.64	(1.03)	1.56	(1.07)	0.090	0.173
Lean meat and alternatives	1.86	(0.90)	2.00	(1.10)	1.90	(1.07)	0.170	0.236
Extra foods	4.86	(1.85)	4.57	(2.05)	4.63	(1.95)	0.695	0.888
Takeaway type foods[c]	0.02	(0.06)	0.02	(0.04)	0.02	(0.04)	0.590	0.598

[a] Analyses for men were adjusted for age and education; analyses for women were adjusted for age, education and occupation.
Some participants did not answer the fruit and/or vegetable questions. Men: someone else n=503 for fruit, n=504 for vegetables; who share n=429 for fruit, n=429 for vegetables. Women: who share n=362 for fruit; myself n=979 for vegetables.
Statistical P-value for differences in means, calculated using analysis of variance.
[b] The vegetables food group excludes potatoes.
[c] Takeaway type foods include hamburgers, pizza, hot chips/roast potatoes/potato wedges, fried fish, meat pies/sausage rolls/other savoury pastries.

Figure 4.A.1. Percentage of men and women achieving each number of dietary guidelines by level of involvement in purchasing the groceries



Men: someone else n=503, shared n=429, myself n=300. Women: someone else n=103, shared n=362, myself n=978.

See Section 2.4.3 for the dietary recommendations for Australian adults.

Weight status

For men, sharing the responsibility of purchasing the groceries was associated with slightly lower prevalence of abdominal obesity and being overweight but the results were not statistically significant (Table 4.A.4). Whilst none of the trends reached statistical significance, for women, increased involvement in food purchasing was associated with reduced prevalence of moderate abdominal obesity and being overweight.

Table 4.A.4. Prevalence ratios for abdominal obesity and BMI ≥25kg/m^2 by who purchases the groceries for Australian men and women aged 26-36 years

				Unadjusted		Adjusted[a]	
Obesity Measure	n	N	%	PR	95% CI	PR	95% CI
Men							
Waist circumference ≥94cm							
Someone else	132	425	31.1	1.00		1.00	
Shared	97	370	26.2	0.95	0.90, 1.01	0.94	0.88, 1.00
Myself	61	247	24.7	0.94	0.87, 1.01	0.97	0.89, 1.05
BMI ≥25kg/m^2							
Someone else	276	425	65.0	1.00		1.00	
Shared	225	370	60.8	0.96	0.90, 1.03	0.95	0.89, 1.03
Myself	144	246	58.5	0.94	0.87, 1.01	1.00	0.91, 1.09
Women							
Waist circumference ≥80cm							
Someone else	36	94	38.3	1.00		1.00	
Shared	92	277	33.2	0.95	0.85, 1.06	0.94	0.84, 1.05
Myself	252	739	34.1	0.96	0.87, 1.06	0.92	0.83, 1.02
BMI ≥25kg/m^2							
Someone else	42	94	44.7	1.00		1.00	
Shared	106	277	38.3	0.94	0.84, 1.05	0.93	0.83, 1.05
Myself	278	740	37.6	0.93	0.84, 1.03	0.90	0.81, 1.00

PR, prevalence ratio, calculated using log binomial regression. n, number of participants with abdominal obesity or BMI ≥25kg/m^2. N, total number of participants in each meal preparation group.
[a] Analyses for men were adjusted for age, marital status and occupation and (log transformed) TV viewing. Analyses for women were adjusted for age, education and occupation.

Table 4.A.5 shows participant's level of involvement in purchasing the food by involvement in meal preparation. The percent agreement between involvement in meal preparation and purchasing the groceries was 69% for men and 73% for women.

Table 4.A.5. The percentage of men and women at each level of involvement in purchasing the groceries by level of involvement in meal preparation

	Involvement in purchasing the groceries							
Involvement in	Someone else		Shared		Myself		Nobody	
meal preparation	n	%	n	%	n	%	n	%
Men	N=522		N=440		N=311		N=0	
Someone else	395	75.7	132	30.0	30	9.7	0	0
Shared	68	13.0	240	54.6	27	8.7	0	0
Myself	47	9.0	63	14.3	247	79.4	0	0
Nobody	12	2.3	5	1.1	7	2.3	0	0
Women	N=109		N=378		N=1017		N=3	
Someone else	64	58.7	53	14.0	52	5.1	1	33.3
Shared	15	13.8	206	54.5	125	12.3	0	0
Myself	29	26.6	113	29.9	829	81.5	0	0
Nobody	1	0.9	6	1.6	11	1.1	2	66.7

4.A.3 Conclusion

Level of involvement in purchasing the groceries was not strongly associated with diet quality or weight status for men or women. Level of involvement in purchasing the food was not a better predictor of diet quality or weight status than involvement in meal preparation. In fact there were fewer significant associations for food purchasing than for involvement in meal preparation in this sample of young adults. The majority of participants had the same level of involvement in purchasing the food as they did with preparing the main meal, with approximately 70% agreement between the two behaviours for men and for women.

Chapter 5. Takeaway food consumption and its associations with diet quality and abdominal obesity: a cross-sectional study of young adults

5.1 Preface

The research in the previous chapters reported that involvement in meal preparation and food purchasing were not strongly associated with diet quality or abdominal obesity. That research related primarily to food consumption behaviours in the home. The research presented in this chapter investigates food purchased outside the home and examines whether takeaway food consumption is associated with diet quality and abdominal obesity.

Few studies have investigated the associations of takeaway food consumption with overall diet quality and abdominal obesity. Young adults are high consumers of takeaway food and therefore the CDAH study provided an excellent sample to examine these associations. The text from this chapter has been published online at the International Journal of Behavioural Nutrition and Physical Activity (1).

5.2 Introduction

Consuming takeaway or fast food is becoming more prevalent in Australia (2) and around the world (3, 4). Although there are no standard definitions, fast food is the term used in North America and typically includes food that can be obtained quickly such as burgers, fries, pizza and fried chicken. Takeaway is the common term used in Australia and includes fast food and other “take out” meal options such as Thai and Indian food. The majority of previous studies were conducted in the USA and focused on fast food. Although it is known that takeaway and fast food consumption is higher in younger age groups than older age groups (5-10) and consumption of fast food has been shown to increase from adolescence to young adulthood (11), there is little research focusing on the correlates of takeaway food consumption in young adults. Furthermore, the socio-demographic and lifestyle characteristics of individuals eating takeaway food have not previously been reported separately for men and women (5, 7-10). It is important to see if the characteristics associated with high takeaway food consumption differ between men and women and to identify groups that consume high levels of takeaway food.

A high frequency of takeaway and fast food consumption has been linked to poorer diet quality including a lower intake of vegetables (6, 8, 9, 12), wholegrains (8), low fat dairy (8) and fruit (8, 10, 12), a higher intake of total fat and saturated fat (9, 12), sodium (12) and non-diet carbonated soft drinks (5). Although these studies have shown an association between takeaway and fast food frequency and individual foods, food groups or nutrients, only one previous study from Spain in 1999 measured overall diet quality (10). However, in that study, the fast food variable included only four items (hamburgers, cheeseburgers, Big Macs and French fries (10)) and excluded other common forms of takeaway food such as pizza, fried chicken, Indian, Chinese and Thai food.

In addition to poorer diet quality, an association between takeaway and fast food consumption and body weight has been reported. The Coronary Artery Risk Development in Young Adults (CARDIA) study in the USA found participants who ate fast food more than twice a week at baseline in 1985 and at the 15 year follow-up had gained an extra 4.5kg compared with participants who ate fast food less than once a week at both time points (8). In Spain, participants eating fast food more than once per week had an increased likelihood of being obese (OR 1.29; P=0.057) compared with non-consumers (10). In an Australian study in 1996, women eating takeaway once per week were 15% less likely to maintain their weight over a four year period compared with women who ate takeaway never or no more than once per month (13).

Most studies examining associations of fast food or takeaway food consumption and obesity have used body mass index (BMI) as a measure of obesity. Waist circumference is thought to be a better indicator of cardiovascular disease and type 2 diabetes risk than BMI (14, 15) as fat distributed around the waist is more harmful than overall obesity. In addition, young adults with high muscle mass might be misclassified as being overweight when using BMI, though the proportion misclassified is not known. One previous study investigating Australian adults living in rural areas during 2001-2003 found no association between high takeaway food consumption and abdominal obesity (16) when using waist circumference as a continuous variable. The authors did not report their findings using recommended cut points for waist circumference to define obesity (17).

The aims of this cross-sectional study of young adults were to examine the socio-demographic and lifestyle factors associated with takeaway food consumption in men and women; and to examine associations of takeaway food consumption with diet quality and abdominal obesity.

5.3 Methods

5.3.1 Participants

The Childhood Determinants of Adult Health (CDAH) study is a follow-up of children who participated in the 1985 Australian Schools Health and Fitness Survey (ASHFS), a nationally representative study of 8,498 children aged 7-15 years (18).

During 2001-2002 participants were traced through electoral rolls, telephone directories, the

National Death Index and contact with class mates. Of the 6,840 (80%) participants successfully traced, 5,170 (61%) were enrolled in the CDAH study and invited to complete questionnaires and attend one of 34 study clinics around Australia for physical measurements. The clinics were held in each state and territory of Australia during 2004-2006, when the participants were aged 26-36 years. Clinics involved a range of physical assessments including anthropometric measurements. In total, questionnaires were completed by 2,881 participants, and 2,410 attended study clinics. The number of participants attending clinics was lower than those enrolled in the CDAH study largely due to the burden of attending the clinic (approximately three hours of testing) and the distance needed to travel.

The study was approved by the Southern Tasmania Health and Medical Research Ethics Committee and all participants gave informed written consent.

5.3.2 Dietary assessment

Food intakes and habits were measured using a 127 item food frequency questionnaire (FFQ) and a food habits questionnaire (FHQ). The FFQ asked for the average number of times each food and beverage was consumed over the previous 12 months. For each item participants were asked to choose one of nine response options ranging from “never or less than once a month” to “6+ times per day”. Daily equivalents were calculated for each FFQ item, assuming one serve was consumed at each eating occasion (19, 20). The mid value was used when the response option included a range of values and missing items were given a value of zero. The FFQ was a modified version of one previously used in the 1995 National Nutrition Survey (20-23) and was based on an existing FFQ developed for Australian populations (24).

The FHQ included questions on takeaway food consumption, daily fruit and vegetable consumption, and frequency of trimming fat from meat. The takeaway food question asked “How many times per week would you usually eat hot takeaway meals (e.g. pizza, burgers, fried or roast chicken, Chinese/Indian/Thai takeaway)”. Participants could choose one of five answers ranging from “I don’t eat takeaway” to “6-7 meals per week”. For analysis, the answers were dichotomised to once a week or less or twice a week or more as there were small numbers in the lowest and the two higher frequency groups. To assess its validity, responses to the takeaway food question were compared with reported consumption of foods in the FFQ that are commonly eaten as takeaway foods (fried fish, meat pie/sausage roll/other savoury pasties, pizza, hamburger, hot chips/roast potato/potato wedges).

Daily fruit and vegetable consumption came from the two short questions: “How many serves of fruit do you usually eat each day?” and “How many serves of vegetables (excluding potatoes) do you usually eat each day?”. Examples of serving sizes were given and the response options were “I don’t eat this food", "1 serve or less", "2-3 serves", "4-5 serves" or "6 or more serves". These short questions have been used in previous studies (20, 25) and have been shown to be valid measures for fruit and vegetable intake (26).

Questions from the FFQ and FHQ were used to determine if participants were complying with sex and age-specific recommendations in the Australian Guide to Healthy Eating (AGHE) (27). The AGHE has been developed to encourage the public to adopt healthy eating patterns by highlighting the foods that help meet nutrient recommendations and provides two recommended patterns of eating. The recommended eating pattern used in this analysis is the most commonly used and is consistent with public health messages that promote consumption of five servings of vegetables and two servings of fruit per day (28). This eating pattern is also the more conservative of the two for vegetables, fruits and dairy for men. The AGHE recommends adults consume the following number of serves from the five food groups each day: two servings of fruit, five servings of vegetables, two servings of dairy, one serving of lean meat or alternatives and six to twelve servings of breads and cereals for men or four to nine servings of breads and cereals for women.

Foods that do not fit into the five core food groups are "extra" foods and are high in fat, salt and sugars and provide very few essential nutrients (27). The AGHE recommends that these foods be eaten in small amounts. Examples of extra foods include ice cream, cream, cakes, sweet pies, desserts, sweet biscuits, chocolate biscuits, savoury pastry, pizza, hamburgers, hot chips, fried fish, chocolate, other confectionary, crisps, dressings, mayonnaise, jam, creamy dips, fruit drink, cordial, soft drink and all alcohol. The guidelines recommend limiting the number of extra foods to no more than three servings per day for men and no more than two and a half servings per day for women. For analysis the extra foods variable was created excluding the takeaway food items (hamburgers, pizza, hot chips, fried fish and savoury pastry), so that takeaway food items could be distinguished separately.

For comparison with the AGHE, information on daily servings of fruit and vegetables came from the short questions in the FHQ. Daily serves of breads and cereals, dairy, lean meat and alternatives and extra foods were obtained from summing daily equivalents calculated from the FFQ (see Appendix 2.B for items included in each food group). For breads and cereals, the lowest recommended value was used, and for extra foods participants not exceeding the upper limit were classified as meeting the recommendation. In line with the Dietary Guidelines for Australian Adults high fat meats were not included in the meat and alternatives food group (29). However, some meat items that would be considered lean if the visible fat was removed were included as lean meats (see Appendix 2.B) if participants reported in the FHQ that they "usually" trimmed the fat from their meat either before or after cooking. The analysis of fruit and vegetable intake was also repeated using items from the FFQ.

5.3.3 Anthropometric measurements

For the anthropometric measurements, participants were standing and dressed in light clothing without shoes. All measurements were made by trained staff. Waist circumference was measured in triplicate over light clothing at the narrowest point between the lower costal border and the iliac crest, at the end of normal expiration. Measurements were taken using a Lufkin steel (non-stretch) tape measure and were recorded to the nearest 0.5cm. Moderate abdominal obesity was defined as ≥94cm for men and ≥80cm for women. These cut points were defined by the World Health Organization and are associated with an increased risk of metabolic complications associated with abdominal obesity (17).

Body weight was measured using a Heine portable scale (Heine, Dover, NH, USA) and recorded to the nearest 0.1kg. Height was measured using a portable Leicester stadiometer (Invicta, Leicester, UK) and recorded to the nearest 0.1cm. BMI (kg/m^2) was calculated from height and weight.

5.3.4 Covariates

Demographic variables included age, sex, education (classified as school only, vocational, university), employment status (working versus not in the workforce) and marital status (married or living as married versus other). Smoking was classified based on self-report as never, former or current smoker.

The long version of the International Physical Activity Questionnaire (IPAQ) was used to assess frequency, duration and intensity of physical activity (30). Participants were asked to report the number of days in the previous week they had done each activity for more than 10 minutes at a time, and how long they would usually spend doing each activity. The leisure time physical activity (LTPA) domain was used in the analysis. Weekday and weekend sedentary behaviour over the previous week was also estimated using the IPAQ. Participants reported the average amount of time they had spent sitting on weekdays and weekend days during the previous week. This question has been shown to have acceptable reproducibility (one week test-retest reliability intraclass correlation range of 0.74 to 0.89) and comparative validity (rank correlation with one week accelerometer counts range of 0.20 of 0.51) (30). In addition, participants' reported total time spent watching television, videos or DVDs when it was the main activity they were doing. This question has also been shown to have acceptable reproducibility (one week test-retest intraclass correlation coefficient of 0.82) and comparative validity (rank correlation with three day sedentary behaviour log of 0.3) (31).

The frequency of consumption of nine alcoholic beverages from the FFQ and their average alcohol concentration (32) was used to estimate the number of standard drinks (10 gram of alcohol) consumed per week. Responses of never or less than once per month were given a value of zero. Participants were classified as non-drinkers, drinkers who consume up to 14 drinks per week, or drinkers who consume more than 14 drinks per week. These groups were based on Australian alcohol guidelines for low-risk drinking (33).

5.3.5 Statistical analyses

Prevalence ratios estimated using log binomial regression or Poisson regression with robust standard errors (34) were used to summarise the associations of socio-demographic and lifestyle variables, and moderate abdominal obesity with takeaway food consumption. Analyses were conducted separately for men and women. Covariates included in the adjusted analyses of obesity and takeaway food consumption were those that plausibly were causally related to the outcome or were markers of other factors causally related to the outcome, were not intermediate on the postulated pathway, and produced at least a 10% change in the parameter estimate for the study factor. They included age, LTPA, (log transformed) TV viewing and employment status. Continuous variables were entered into the model as continuous covariates. Additional adjustments for marital status, education, smoking status, alcohol intake and other measures of physical activity did not materially alter the results. Interactions between takeaway food consumption and other covariates were assessed by including product terms as additional covariates.

Chi square analysis was used to examine the association between takeaway food consumption and meeting the dietary recommendations in the AGHE (27).

All statistical analyses were conducted with STATA software (version 9.2, 2007, Statacorp, College Station, Texas).

5.4 Results

In total, 2,881 participants answered the dietary questionnaires. Nineteen participants did not answer the takeaway food question and were excluded from all analyses. The remaining 2,862 participants were included in the analysis of socio-demographic and lifestyle factors associated with takeaway food consumption. The dietary recommendation analysis excluded 78 women who were pregnant at the time of data collection because different dietary recommendations exist for pregnant women. A further 99 participants were excluded from the dietary recommendation analysis because they failed to provide responses to 10% or more of the FFQ items (n=2,685 for analysis). The abdominal obesity analysis was restricted to clinic attendees who had anthropometric measurements and excluded pregnant women (n=2,194 for analysis).

The socio-demographic characteristics and anthropometric measurements (for clinic attendees) of 2,862 participants (99.3% of questionnaire respondents) are shown in Table 5.1. The mean waist circumference (cm) was 89.5 (SD 10.6) for men and 78.2 (SD 11.4) for women. Men had a mean BMI of 26.5 (SD 4.2) kg/m^2, while women had a mean BMI of 25.0 (SD 5.2) kg/m^2.

While the study sample was derived from a nationally representative sample of children first measured in 1985, only one third participated in the follow-up in adulthood. Compared with the general Australian population of similar age (25-34 years) this study sample had a higher proportion of participants who were married or living as married (57% of men and 64% of women in the general population (35)), and a higher proportion of professionals and managers (40% of men and 38% of women in the general population (36)). The proportion of participants who were classified as overweight or obese (BMI ≥25kg/m^2) was similar to the general population (58% of men and 35% of women (37)).

Table 5.1. Socio-demographic and anthropometric characteristics of participants

Socio-demographic/anthropometric characteristic	Men (N=1277) [a]		Women (N=1585) [a]	
	%	n	%	n
Age (mean, SD)	31.7	2.6	31.6	2.6
Married or living as married	66.9	854	72.2	1144
Education				
University	37.3	475	45.1	714
Vocational	35.7	455	26.0	412
School only	26.9	343	28.9	457
Occupation				
Professional or manager	57.1	719	49.0	763
Non-manual	7.6	96	26.5	421
Manual	31.7	399	5.1	79
Not in workforce	3.6	45	19.5	303
BMI [b]				
Normal (<25kg/m^2)	38.4	409	62.0	701
Overweight (25-29.9kg/m^2)	45.4	483	23.8	269
Obese (≥30kg/m^2)	16.2	172	14.2	160
Waist circumference (cm) [b]				
Normal	72.4	771	65.9	744
Moderate abdominal obesity [c]	27.6	294	34.1	385

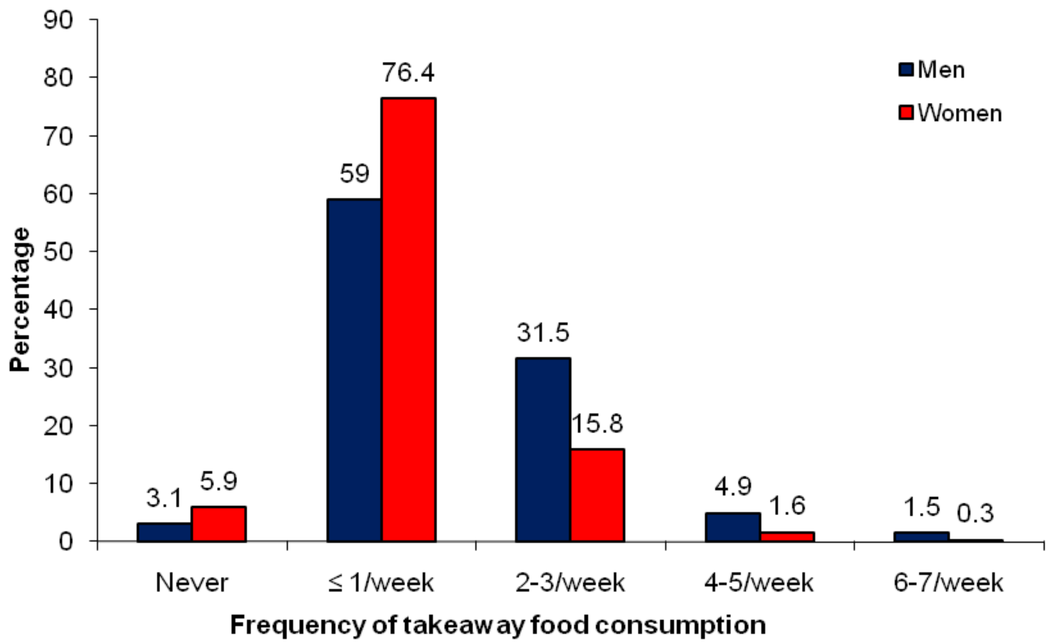
[a] Sample sizes vary due to missing data (range 1,259 to 1,277 for men, 1,557 to 1,585 for women).
[b] Anthropometric measurements are for clinic attendees only and exclude pregnant women (men n=1,065, women n=1,129).
[c] Moderate abdominal obesity was defined as ≥94cm for men and ≥80cm for women.

5.4.1 Takeaway food consumption

The majority of participants (62.1% men and 82.3% women) ate takeaway once a week or less (Figure 5.1). Men consumed takeaway more frequently than women, with 37.9% of men and 17.7% of women eating takeaway at least twice a week (P<0.001).

Our validation analysis showed takeaway food consumption from the short question in the FHQ was consistent with reported consumption of foods that are commonly eaten as takeaway food in the FFQ. Intake of the takeaway type foods was higher in participants who reported in the short question that they ate takeaway twice a week or more (52.8%, 383/725) than in participants who reported eating takeaway once a week or less (18.1%, 355/1,960).

Figure 5.1. Frequency of takeaway food consumption for men and women



Difference between men (N=1,277) and women (N

=1,585), P<0.001.

5.4.2 Takeaway food consumption and socio-demographic and lifestyle variables

Men who consumed takeaway at least twice a week were more likely to be single, younger, current smokers, to spend more time watching TV and to spend more time sitting (Appendix 5.A, Table 5.A.1). Women who consumed takeaway at least twice a week were more likely to be single, in the workforce, and to spend more time watching TV and sitting.

5.4.3 Achieving the dietary recommendations

The proportions of data that were missing were less than 10% in all food groups apart from lean meat and alternatives (37%). The proportions of missing data in each food group were not significantly different by takeaway food consumption, with the exception of lean meat; those consuming takeaway twice a week or more had more missing data (P=0.043 for men, P=0.033 for women).

Overall, compliance with the dietary recommendations was low, except for the lean meat and alternatives recommendation. Compliance was generally lower in participants who ate takeaway food more frequently (Table 5.2). Men who ate takeaway twice a week or more were significantly less likely to achieve the dietary recommendations for breads and cereals, vegetables, fruit, dairy and extra foods. A similar result was found for women with those eating takeaway twice a week or more being significantly less likely to achieve the dietary recommendations for vegetables, fruit, dairy, lean meat and alternatives, and extra foods. Overall participants eating takeaway twice a week or more met fewer of the dietary recommendations (Table 5.3).

Table 5.2. Percentage of men and women achieving dietary recommendations for Australian adults by takeaway food consumption

Dietary recommendation[a]	Consuming takeaway ≤1/week			Consuming takeaway ≥2/week			P-value
	%	n	N	%	n	N	
Men[b]							
Breads and cereals (6-12)	5.3	41	774	2.6	12	462	**0.023**
Vegetables[c] (5)	8.7	67	773	5.0	23	460	**0.017**
Fruit (2)	43.4	335	772	30.7	141	460	**<0.001**
Dairy (2)	41.3	320	774	32.9	152	462	**0.003**
Lean meats and alternatives (1)	81.8	633	774	79.7	368	462	0.356
Extra foods (excluding takeaway) (0-3)	38.0	294	774	28.4	131	462	**0.001**
Women[b]							
Breads and cereals (5-9)	16.5	196	1186	18.3	48	263	0.499
Vegetables[c] (5)	14.2	168	1184	8.0	21	263	**0.007**
Fruit (2)	51.8	613	1184	34.6	91	263	**<0.001**
Dairy (2)	39.5	468	1186	29.3	77	263	**0.002**
Lean meats and alternatives (1)	89.1	1057	1186	84.4	222	263	**0.032**
Extra foods (excluding takeaway, 0-2½)	40.9	485	1186	30.0	79	263	**0.001**

[a] Daily Dietary Recommendations for Australian Adults aged 19-60 years are presented in the table in parentheses' after each food group. Participants consuming at least the lower value for breads and cereals and not exceeding the upper limit for extra foods were classified as meeting the recommendation.
[b] Analysis excluded participants missing at least 10% of the FFQ (n=99) and pregnant women (n=78).
[c] Participants classified as meeting the vegetable recommendation are consuming 4-5 serves/day not 5 as per the recommendation.

Table 5.3. Number of dietary recommendations men and women were achieving by takeaway food consumption

Number of recommendations[a] achieved	Consuming takeaway ≤1/week		Consuming takeaway ≥2/week		P-value
	%	n	%	n	
Men		N=772		N=460	
0	4.9	38	7.2	33	
1	22.8	176	32.6	150	
2	36.4	281	40.2	185	
3	23.1	178	14.6	67	
4-6	12.8	99	5.4	25	**P<0.001**
Women		N=1183		N=263	
0	2.6	31	4.6	12	
1	18.7	221	29.7	78	
2	28.6	338	33.1	87	
3	29.4	348	23.2	61	
4-6	20.7	245	9.5	25	**P<0.001**

[a] Daily Dietary Recommendations for Australian Adults aged 19-60 (see Section 2.4.3). Participants consuming at least the lower value for breads and cereals and not exceeding the upper limit for extra foods were classified as meeting the recommendation. Participants classified as meeting the vegetable recommendation are consuming 4-5 serves/day.
Note: P-values calculated using Chi square analysis with groups 4-6 combined so cell values were all >5.

When we repeated the fruit and vegetable analysis using daily intakes calculated from the FFQ, the intake of vegetables (men and women) and fruit (men only) was higher than with the short questions. This meant that a higher number of participants were classified as meeting these recommendations. However, the proportion meeting the recommendations remained significantly lower in participants who ate takeaway more frequently. This is consistent with the results using the short questions from the FHQ.

Milk in hot beverages was not included in the main analysis of the dairy food group because doing so could overestimate dairy intake for people who only add a small amount of milk to their hot drink. When we included milk consumed in hot beverages, we found a greater proportion of participants met the recommendations for dairy intake. For men, the difference between the takeaway food groups was no longer significant (71.0% consuming takeaway foods once a week or less versus 73.5% consuming takeaway food twice a week or more, P=0.337), whereas for women, those eating takeaway once a week or less remained more likely to meet the guidelines compared with those eating takeaway twice a week or more (78.4% versus 68.4%, respectively, P=0.001).

5.4.4 Factors associated with moderate abdominal obesity

Men with moderate abdominal obesity were more likely to be married (P<0.005), older (P=0.005) and watch more TV (P=0.001). There was a non-linear trend for education where men with higher education were more likely to have moderate abdominal obesity (P<0.001). Women with moderate abdominal obesity tended to be older (P=0.024), less educated (P<0.001), not in the workforce (P<0.001), current smokers (P=0.018), non-drinkers (P=0.001), spend more time watching TV (P<0.001), less physically active (P=0.007), and to have more children (P=0.002).

5.4.5 Takeaway food consumption and moderate abdominal obesity

Men consuming takeaway at least twice a week were 33% more likely to have moderate abdominal obesity compared with men who ate takeaway once a week or less (Table 5.4). This difference remained after adjusting for age, LTPA, TV viewing and employment status. Women consuming takeaway at least twice a week were 22% more likely to have moderate abdominal obesity compared with women consuming takeaway once a week or less. This increased slightly to 25% after adjusting for age, LTPA, TV viewing and employment status. An interaction (P=0.049) was found for women between smoking status and takeaway food consumption with the effect of takeaway food consumption on waist circumference being strongest in never smokers (data not shown).

The adjustments for LTPA, TV viewing and employment status (men) reduced the coefficient of takeaway food consumption in the regression of waist circumference because those factors were negatively (LTPA) or positively (TV viewing, employment status of men) correlated with waist circumference. Adjusting for age and employment status (women) increased the coefficient of takeaway food consumption because those factors were negatively (employment status of women) or positively (age) correlated with waist circumference. In multivariable analysis, these four factors were significant predictors of consuming takeaway food at least twice a week.

When using BMI in place of waist circumference as the outcome variable, an association with takeaway food consumption was only found for men classified as being obese though this association was not statistically significant. In contrast, women eating takeaway food twice a week or more had a significantly higher prevalence of overweight and obesity.

Table 5.4. Prevalence ratios of overweight and obesity for frequency of takeaway food consumption

Measure of overweight and obesity	Frequency of takeaway food consumption	%	n	N	Unadjusted		Adjusted[a]	
					PR	95% CI	PR	95% CI
Men								
WC ≥94cm	≤1/week	24.4	158	647	1.00		1.00	
	≥2/week	32.5	136	418	**1.33**	**1.10, 1.62**	**1.31**	**1.07, 1.61**
BMI ≥25kg/m^2	≤1/week	61.8	400	647	1.00		1.00	
	≥2/week	61.2	255	417	0.99	0.90, 1.10	0.98	0.88, 1.09
BMI ≥30kg/m^2	≤1/week	14.7	95	647	1.00		1.00	
	≥2/week	18.5	77	417	1.26	0.96, 1.65	1.21	0.90, 1.63
Women[b]								
WC ≥80cm	≤1/week	32.7	297	909	1.00		1.00	
	≥2/week	40.0	88	220	**1.22**	**1.02, 1.48**	**1.25**	**1.04, 1.50**
BMI ≥25kg/m^2	≤1/week	36.5	332	910	1.00		1.00	
	≥2/week	44.1	97	220	**1.21**	**1.02, 1.44**	**1.22**	**1.03, 1.45**
BMI ≥30kg/m^2	≤1/week	13.3	121	910	1.00		1.00	
	≥2/week	17.7	39	220	1.33	0.96, 1.85	1.29	0.93, 1.80

PR, prevalence ratio, calculated using log binomial regression. WC, waist circumference.
[a] Adjusted for age, leisure time physical activity, TV viewing and employment status.
[b] Pregnant women (n=78) were excluded from this analysis.

5.5 Discussion

We have shown takeaway food consumption is associated with a poorer diet quality and a higher prevalence of moderate abdominal obesity in young Australian adults. Different socio-demographic and lifestyle factors are associated with a higher frequency of takeaway food consumption in men and women.

Differences in the methods used to ascertain takeaway and fast food consumption and the definition of takeaway or fast food used make it difficult to compare findings across studies. The frequency of takeaway food consumption in the current study was higher than that reported in a Mediterranean population (aged 24-75 years) where only 1.1% were consuming fast food at least twice per week but only hamburgers, cheese burgers, Big Macs and French fries were included as fast food (10). A study in the USA reported 30% of men and 24% of women (aged 20 years and older) had consumed fast food on at least one of the two days studied using 24-hour diet recalls (5).

The socio-demographic and lifestyle characteristics we found to be associated with higher frequency of takeaway food consumption were similar to those found in previous studies: younger age (6, 9), being single (8, 10) and watching more TV (8). However, to our knowledge this is the first study to report characteristics of takeaway food consumption separately for men and women. Being single and spending more time watching TV and sitting were associated with takeaway food consumption in both sexes. In men, being younger and a current smoker were also associated with takeaway consumption whereas in women, there was an association with employment status.

We found men consumed takeaway more frequently than women, which is consistent with some studies (7, 38), but not others (9, 10). In contrast to a previous study we found no significant association between takeaway food consumption and alcohol consumption in men or women (8).

Studies of socio-economic position and diet quality report that people of lower socio-economic status consume diets that are higher in energy dense foods such as takeaway foods (39). However, our measures of socio-economic status (employment status and education) in this sample of young Australian adults do not support this. Participants who were not in the workforce were not high consumers of takeaway food, possibly because they could not afford to purchase it, and education had no association with takeaway food consumption. Previous studies investigating associations between income and takeaway food consumption have reported mixed results with some studies reporting participants with a high income to be the highest consumers (7, 12), some showing participants with a low income to be the highest consumers (6), and yet others showing no association (16). Education also shows mixed results with the majority of studies being consistent with our finding of no association (7, 9, 16), but others have reported positive associations with high education (10) or low education (8).

The number of participants achieving individual dietary recommendations was very low and lowest in participants who were eating takeaway food more frequently. This suggests takeaway food is not just an additional food item in an otherwise healthy diet but is associated with a number of other unhealthy eating behaviours, possibly by displacing healthier items from the diet. Our findings are similar to previous studies from the USA and Spain that report a higher frequency of takeaway or fast food consumption is associated with a lower intake of fruit, vegetables and dairy (6, 8-10). A higher frequency of takeaway food consumption was associated with a lower intake of breads and cereals in men and a lower intake of lean meats and alternatives in women. Overall, participants eating takeaway food more frequently met fewer of the dietary recommendations. This supports the previous study in Spain that examined overall diet quality, where participants eating fast food at least twice per week had the lowest adherence to the Healthy Eating Index and the Mediterranean Diet Score (10).

This is the first study to show that young adults eating takeaway more frequently have a somewhat higher prevalence of moderate abdominal obesity as measured by waist circumference. Women eating takeaway food twice a week or more had a higher prevalence of being overweight or obese as defined by a BMI ≥25 kg/m^2 and this association remained significant after adjusting for covariates. However, in men, an association was only seen at the higher level of BMI (≥30kg/m^2) and the association was not significant. While we were unable to adjust for energy intake, because this was not available from the FFQ, we did take into account key determinants of energy intake by stratifying the analysis by sex and adjusting for age and physical activity levels. Due to the cross-sectional analysis, we cannot be certain of the direction of a causal relationship between takeaway food consumption and abdominal obesity. Although our study sample comes from a cohort study, longitudinal analysis is not possible because comparable dietary data were not collected in childhood. Previous studies have found an association between takeaway and fast food consumption and BMI (10) and changes in weight over time (6, 8, 13, 40).

There are several limitations with the dietary recommendation analysis. The response option for the vegetable question combined four and five serves per day, and the proportion meeting the vegetable recommendation (at least five daily serves) is likely to be lower than that reported here. In addition, compliance with the lean meat and alternatives recommendation may be overestimated due to the large number of items included in this variable. However, previous national data show consumption of meat and alternatives is high in Australian adults (41). Although we excluded from the analysis participants who had not adequately completed the questionnaire (those that failed to complete >90% of the FFQ), we were left with occasional non-responses to items by the remaining respondents. These were assigned a value of zero on the grounds that a non-response indicated the respondent did not eat that food. However, some of these missing items may have been overlooked by the respondent. If so, this would have resulted in under-estimation of the proportion of respondents meeting the dietary recommendations. It is reassuring that this measurement error did not appear to be differential between the two takeaway food groups, with the exception of the lean meat and alternatives food group. The guidelines recommend consuming whole grain breads and cereals; apart from bread, the FFQ did not distinguish between wholegrain and non-wholegrain items. Components of mixed dishes were not included as items in the food groups and may be under-estimated. Mixed dishes are generally difficult to assess using FFQs (42).

A strength of this study was that we asked about *usual* takeaway food consumption and, in addition to food available from the main fast food chains (McDonalds, Pizza Hut, KFC etc), our takeaway food variable included other popular takeaway food options such as Indian, Thai and Chinese foods. Furthermore, this is the first study to report associations of takeaway food consumption with lifestyle factors separately for men and women. We did this because we were interested in examining potential sex differences in takeaway food consumption to better understand the predictors of this eating behaviour. Other strengths include the use of a FFQ that has been used in previous national surveys, and examining overall diet quality, which has been done in only one previous study.

5.6 Conclusion

In this large nationwide study of young Australian adults we found participants consuming takeaway food at least twice per week met fewer of the dietary recommendations and had a modestly higher prevalence of moderate abdominal obesity compared with participants consuming takeaway once a week or less. Initiatives to reduce takeaway food consumption or to promote healthier takeaway food options have the potential to improve diet quality and prevent obesity.

5.7 Postscript

The research presented in this chapter has shown consuming takeaway food at least twice a week is associated with poorer diet quality and abdominal obesity in both men and women. Little is known about the association between takeaway food consumption and other cardio-metabolic risk factors and this will be examined in the following chapter.

5.8 References

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Appendix 5.A Additional tables

The socio-demographic and lifestyle factors associated with consuming takeaway food at least twice a week are shown in Table 5.A.1. Men who consumed takeaway at least twice a week were more likely to be single, younger, current smokers, to spend more time watching TV and to spend more time sitting. Women who consumed takeaway at least twice a week were more likely to be single, in the workforce, and to spend more time watching TV and sitting.

Table 5.A.1. Socio-demographic and lifestyle factors associated with consuming takeaway food at least twice a week

	Men					Women				
Socio-demographic/lifestyle factor	%	n	N[a]	PR	95% CI	%	n	N[a]	PR	95% CI
Marital Status										
Single	46.3	196	423	1.00		20.7	91	440	1.00	
Married or living as married	33.7	288	854	0.73	0.63, 0.84	16.6	190	1144	0.80	0.64, 1.01
Trend				***P<0.001***					*P=0.055*	
Age										
26-29 years	47.1	136	289	1.00		19.8	82	415	1.00	
30-33 years	38.4	232	604	0.82	0.70, 0.96	18.0	131	729	0.91	0.71, 1.17
34-36 years	30.2	116	384	0.64	0.53, 0.78	15.4	68	441	0.78	0.58, 1.05
Trend				***P<0.001***					*P=0.096*	
Education										
University	36.0	171	475	1.00		17.1	122	714	1.00	
Vocational	39.3	179	455	1.09	0.93, 1.29	17.2	71	412	1.01	0.77, 1.32
School only	38.2	131	343	1.06	0.89, 1.27	19.3	88	457	1.13	0.88, 1.44
Trend				*P=0.471*					*P=0.364*	

Employment status										
Not in the workforce	22.2	10	45	1.00		10.6	32	303	1.00	
In workforce	38.1	462	1214	1.71	0.99, 2.97	19.5	245	1254	1.85	1.31, 2.62
Trend				*P=0.056*					***P<0.001***	
Smoking status										
Never smoked	35.9	282	785	1.00		16.9	158	933	1.00	
Former smoker	37.6	71	189	1.05	0.85, 1.29	19.2	60	312	1.14	0.87, 1.48
Current smoker	46.4	108	233	1.29	1.09, 1.52	20.6	51	248	1.21	0.92, 1.61
Trend				***P=0.005***					*P=0.144*	
Alcohol consumption										
Non-drinker	35.7	41	115	1.00		15.7	50	318	1.00	
≤14 drinks/week	39.1	375	958	1.10	0.85, 1.42	17.7	206	1167	1.12	0.85, 1.49
>14 drinks/week	33.0	66	200	0.93	0.68, 1.27	25.5	25	98	1.62	1.06, 2.48
Trend				*P=0.413*					*P=0.058*	
TV viewing										
<8 hours/week	35.0	111	317	1.00		13.7	73	532	1.00	
8-14 hours/week	36.0	128	356	1.03	0.84, 1.26	15.8	80	506	1.15	0.86, 1.54
15-21 hours/week	35.9	98	273	1.03	0.82, 1.28	24.3	67	276	1.77	1.31, 2.38
>21 hours/week	48.1	101	210	1.37	1.12, 1.69	27.0	47	174	1.97	1.42, 2.72
Trend				***P=0.006***					***P=<0.001***	
Sitting										
<20 hours/week	31.7	66	208	1.00		12.6	39	310	1.00	
20-40 hours/week	36.9	152	412	1.16	0.92, 1.47	15.8	92	581	1.26	0.89, 1.78
41-60 hours/week	40.4	128	317	1.27	1.00, 1.62	22.7	85	375	1.80	1.27, 2.55

>60 hours/week	41.0	91	222	1.29	1.00, 1.67	23.9	52	218	1.90	1.30, 2.77
Trend				***P=0.032***					***P<0.001***	
Leisure time physical activity										
≤1.0 hour/week	39.4	194	493	1.00		19.7	124	630	1.00	
1.1-3 hours/week	34.2	97	284	0.87	0.71, 1.06	17.4	72	414	0.88	0.68, 1.15
3.1-5 hours/week	42.7	73	171	1.08	0.88, 1.33	19.3	47	243	0.98	0.73, 1.33
>5 hours/week	34.1	74	217	0.87	0.70, 1.07	12.9	28	217	0.66	0.45, 0.96
Trend				*P=0.426*					*P=0.069*	

PR, prevalence ratio, calculated using log binomial regression.
[a] Sample sizes vary due to missing data (range 1,156 to 1,277 for men, 1,488 to 1,585 for women).

Chapter 6. Takeaway food consumption and cardio-metabolic risk factors in young adults

6.1 Preface

The findings from the previous chapter showed participants who ate takeaway food at least twice a week were less likely to be meeting the dietary recommendations for Australian adults and had a higher prevalence of moderate abdominal obesity, compared to those who ate takeaway once a week or less. Whether takeaway food consumption is associated with other cardio-metabolic risk factors and if any associations are independent of abdominal obesity is not well understood. The text from this chapter is currently under consideration at the European Journal of Clinical Nutrition.

6.2 Introduction

Takeaway and fast food consumption has been shown to be positively associated with adiposity in study populations in the USA, Australia and Europe (1-8). Takeaway and fast foods are thought to contribute to adiposity through high energy density (9) and large portion sizes. In a nationally representative study of American adults, participants consumed an average of 858 more kilojoules on days when they ate fast food than on non-fast food days (1).

In addition to being high in energy, takeaway and fast foods are often high in total and saturated fat and salt (10). These dietary components have been shown to increase total and LDL cholesterol and blood pressure, which are risk factors for cardiovascular disease and type 2 diabetes (11, 12). To our knowledge, only data from the Coronary Artery Risk Development in Young Adults (CARDIA) study in the USA has been used to examine associations between fast food consumption and cardio-metabolic risk factors (2, 4). The CARDIA study is a longitudinal study of over 3,000 participants who were aged 18-30 years at baseline. Participants who consumed fast food more than twice a week at baseline and at the 15 year follow-up had gained, on average, an extra 4.5kg of body weight and had a two-fold greater increase in insulin resistance than those who ate takeaway less than once per week at both time points (4). These associations remained significant after adjusting for socio-economic status and dietary intake, but other important potential confounders or mediators such as overweight and obesity, weight gain and physical activity were not considered for the insulin resistance analysis.

A more recent analysis of the CARDIA data examined associations between cardio-metabolic risk factors and fast food consumption over a 13 year follow-up period (2). Participants in the highest quarter of fast food consumption at baseline had higher waist circumference, insulin resistance, and triglyceride concentrations and lower HDL cholesterol concentrations 13 years later than those in the lowest quarter of fast food consumption. These associations remained significant after adjusting for socio-economic status, lifestyle factors and energy intake at baseline. Whether the associations with lipids and insulin resistance were independent of waist circumference were not reported.

We have previously shown takeaway food consumption to be associated with poorer diet quality and moderate abdominal obesity in young adult men and women (7). The aims of this study were to determine whether takeaway food consumption was associated with cardio-metabolic risk factors in young adults and whether any associations were mediated through obesity.

6.3 Methods

6.3.1 Study population

The Childhood Determinants of Adult Health (CDAH) study is a follow-up of the 1985 Australian Schools Health and Fitness Survey (ASHFS), a nationally representative study of 8,498 children aged 7-15 years (13). During 2001-2002 participants were traced, and invited to attend one of 34 study clinics around Australia during 2004-2006 at age 26-36 years (7). Clinics were attended by 2,410 participants and included anthropometric measurements and collection of fasting blood samples. The study was approved by the Southern Tasmania Health and Medical Research Ethics Committee and all participants gave informed written consent.

6.3.2 Dietary assessment

Frequency of takeaway food consumption was assessed using the question “How many times per week would you usually eat hot takeaway meals (e.g. pizza, burgers, fried or roast chicken, Chinese/Indian/Thai takeaway)”. Participants could choose one of five answers ranging from “I don’t eat takeaway” to “6-7 meals per week”. Chinese, Indian and Thai foods were included because although they can contain more vegetables than other takeaway items they are still often high in fats salt and sugar. For analysis, the responses were dichotomised to once a week or less or twice a week or more as there were small numbers in the lowest and the two highest frequency groups. We have previously shown that takeaway food consumption using this short question is consistent with consumption of takeaway type foods from a food frequency questionnaire (7).

6.3.3 Blood chemistry

Venous blood samples were collected from the antecubital vein after an overnight fast. Triglycerides, total cholesterol, HDL cholesterol and glucose were determined enzymatically using an Olympus AU5400 automated analyser (Olympus Optical, Tokyo, Japan). LDL cholesterol concentration was calculated using the Friedewald formula (14). Two methods were used to determine fasting insulin concentration; microparticle-enzyme immunoassay kit (AxSYM, Abbot Laboritories, Abbort Park, IL) and electrochemiluminescence immunoassay (Elecsys Modular Analytic E170, Roche Diagnostics, Mannheim, Switzerland). A correction factor of 0.81 was applied to the insulin values assessed using the microparticle-enzyme immunoassay. Insulin sensitivity was estimated by the homeostasis model assessment (HOMA) index, calculated as fasting serum insulin (U/m) x fasting glucose (mmol/l)/22.5.

The use of lipid lowering medication and the National Cholesterol Education Program Adult Treatment Panel guidelines (15) were used to classify participants as having high triglycerides (≥2.26mmol/L), total cholesterol (≥6.22mmol/L) or LDL cholesterol (≥4.14mmol/L) or low HDL cholesterol (≤1.1mmol/L).

6.3.4 Blood pressure

Blood pressure was measured three times using a digital automatic monitor (Omron HEM907, Omron Healthcare Inc, Kyoto, Japan). The mean value was used in the analysis. High blood pressure was defined as systolic blood pressure ≥130mmHg and <140mmHg or diastolic blood pressure ≥85mmHg and <90mmHg. Hypertension was defined as use of blood pressure lowering medication or systolic blood pressure ≥140mmHg or diastolic blood pressure ≥90mmHg (16).

6.3.5 Continuous metabolic syndrome score

A continuous metabolic syndrome score was created using the validated methods described by Wijndaele et al (17, 18). A continuous score was used to eliminate the need to dichotomise continuous outcomes and because cardio-metabolic risk increases progressively with increasing numbers of risk factors. Briefly, sex-specific principal components analysis with varimax rotation was applied to normalised International Diabetes Federation metabolic syndrome risk factors (19) to derive the principal components with eigenvalues ≥1.0. Two principal component scores were identified in the CDAH sample that explained 34% and 26% of the variance in men and 31% and 25% of the variance in women (20). These principal component scores were summed and weighted according to the relative proportion of variance explained to compute the continuous metabolic syndrome score.

6.3.6 Covariates

Demographic variables included age, sex, highest level of education achieved (school only, vocational, university), occupation (professional or manager, non-manual, manual, not in workforce) employment status (working versus not in the workforce) and marital status (married or living as married versus other). Smoking was classified based on self-report as never, former or current smoker. Leisure time physical activity (LTPA) was assessed using the long version of the International Physical Activity Questionnaire (21). Time spent watching TV was also assessed (22). Waist circumference was measured three times at the narrowest point between the lower costal border and the iliac crest at the end of normal expiration. The mean of the three measurements was calculated. Weight was measured using a portable scale (Heine, Dover, NH, USA) and height was measured using a portable stadiometer (Invicta, Leicester, UK). BMI (kg/m^2) was calculated. Accessibility/Remoteness Index of Australia classifications (major city, inner regional, outer regional, remote or very remote) were assigned to participants based on census collection districts. Usual daily intake of fruit and vegetables was assessed using short questions (7). Daily fish consumption was calculated from three food frequency questionnaire items. Participants reported how often in the previous 12 months they had consumed canned, fresh and frozen fish. Daily equivalents were calculated and summed to give daily fish consumption (7).

6.3.7 Statistical analysis

Adjusted mean values for cardio-metabolic variables and differences in the adjusted means, were calculated using linear regression. Covariates included in the adjusted analyses were those that were plausibly associated with the outcome, were not intermediates between the exposure and the outcome, and changed the coefficient of the variable for the principal study factor by more than 10% when included in the model (23). Categorical variables were represented in the analyses as binary (0/1) covariates, and scaled covariates were used to represent continuous variables. The dependent variable was transformed where necessary to improve normality of residuals and reduce heteroskedasticity, and the scale of each continuous covariate was checked when included in each regression model. The models were adjusted for age, employment status, leisure time physical activity and (log-transformed) TV viewing. Daily fruit, vegetable and fish consumption was added to the models to examine whether any differences in cardio-metabolic risk factors were explained by differences in dietary intake. Waist circumference and BMI were added to separate models to determine whether the differences were mediated through abdominal obesity or overall obesity.

Log binomial regression was used to test for associations between takeaway food consumption and having high triglycerides, total or LDL cholesterol, low HDL cholesterol, high blood pressure or hypertension. Men and women were analysed separately. The majority of the CDAH sample is Caucasian and therefore the analyses were not stratified by race. All statistical analyses were conducted with STATA software (version 10.1, 2009, Statacorp, College Station, Texas).

6.4 Results

In total, 2,255 participants answered the takeaway food question and gave a fasting blood sample. Participants were excluded from the analysis if they had missing values for covariates included in the adjusted models (n=309) or were pregnant (n=50). This left 1,896 participants for the analysis (22%

of the original ASHFS sample and 84% of those who completed the takeaway food questionnaire). One woman with an influential low glucose concentration (1.6mmol/L) was excluded from the analysis of fasting glucose.

The participant characteristics are shown in Table 6.1. The CDAH sample had a higher percentage of participants who were married or living as married than the Australian population of 25-34 year olds (57% of men and 64% of women in the general population (24)) and a higher percentage employed as professionals or managers (40% of men and 38% of women in the general population (25)). The percentage of participants classified as being overweight or obese (BMI≥25 kg/m^2) was very similar to the Australian population of similar age (58% of men and 35% of women (26)).

Participants who did not attend the study clinics or were excluded from the analyses tended to be of lower SES (35% had a university qualification and 46% were employed as professionals or managers) than those included in the analyses. The percentage classified as being overweight (37%) or obese (16%) was similar to those included in the analyses.

Table 6.1. Socio-demographic, lifestyle and anthropometric characteristics of participants

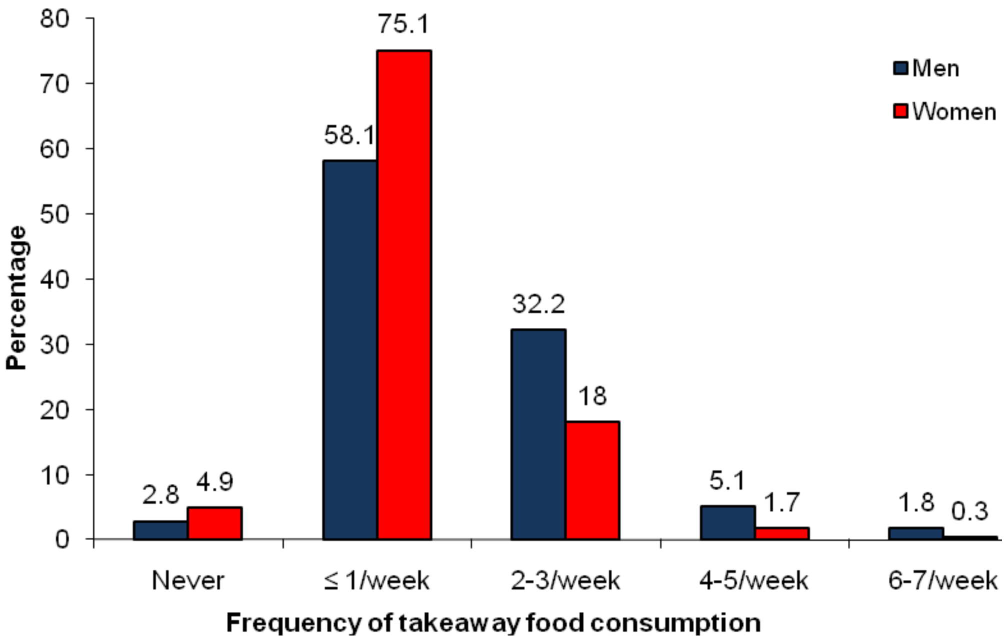
Socio-demographic, lifestyle or anthropometric variable	Takeaway ≤1/week N=1342 n	%	Takeaway ≥2/week N=554 n	%
Male	557	41.5	357	35.6
Age (years; mean, SD)	31.6	(2.6)	31.2	(2.6)
Married or living as married	931	69.4	34.2	61.7
Education				
University	622	46.4	233	42.2
Vocational	388	28.9	174	31.5
School only	331	24.7	145	26.3
Occupation				
Professional or manager	732	54.6	323	58.3
Non-manual	247	18.4	92	16.6
Manual	203	15.1	111	20.0
Not in workforce	160	11.9	28	5.1
Accessibility/Remoteness Index of Australia				
Major city	203	15.1	66	11.9
Inner regional	1030	76.8	454	82.0
Outer regional	98	7.3	33	6.0
Remote or very remote	10	0.8	1	0.2
BMI				
Normal (<25kg/m^2)	721	43.7	251	45.4
Overweight (25-29.9kg/m^2)	439	32.7	201	36.4
Obese (≥30kg/m^2)	182	13.6	101	18.3
Waist circumference				
Normal	963	71.8	355	64.1
Moderate abdominal obesity[a]	379	28.2	199	35.9
Leisure time physical activity				
Minutes per week (mean, SD)	168.0	(201.0)	154.3	(182.8)
TV viewing				
Hours per week (geometric mean, SD)	9.7	(11.0)	12.0	(14.4)

[a] Moderate abdominal obesity was defined as waist circumference ≥94cm for men and ≥80cm for women.

6.4.1 Takeaway food consumption

The majority of participants ate takeaway food once a week or less (60.9% of men and 80.0% of women, Figure 6.1). Takeaway food was consumed twice a week or more by 39.1% of men and 20.0% of women.

Figure 6.1. Frequency of takeaway food consumption for men and women aged 26-36 years.



N=914 for men and N=982 for women

6.4.2 cardio-metabolic risk factors

Takeaway food consumption was not significantly associated with cardio-metabolic risk factors for men (Table 6.2a). Women who ate takeaway at least twice a week had significantly higher mean fasting glucose concentrations and HOMA scores and tended to have higher fasting insulin concentrations than those who ate takeaway once a week or less (Table 6.2b). The results were adjusted for age, employment status, LTPA and TV viewing. Additional adjustments for daily fruit, vegetable and fish consumption did not change the magnitude or the significance of the associations observed (data not shown). When waist circumference was added to the model the differences between those who ate takeaway once a week or less and those who ate takeaway twice a week or more were reduced (mean fasting glucose 4.82 versus 4.87mmol/L respectively, P=0.101; HOMA 1.31 versus 1.37 respectively, P=0.214; fasting insulin 6.10 versus 6.32 mU/L respectively, P=0.313). These differences were not due to participants with diabetes. When those with self-reported diabetes and those with fasting glucose >6mmol/L (18 women: 15 reported eating takeaway once per week or less and three reported eating takeaway twice a week or more) were excluded from the analyses, the difference in glucose concentrations remained (mean glucose 4.84 versus 4.90mmol/L, P=0.052). The strength and the significance of the associations for fasting insulin and HOMA did not change. Men who ate takeaway twice a week or more also had higher fasting insulin concentrations and a higher HOMA score than those who ate takeaway less frequently, but the differences between the two groups were not statistically significant. Adjusting for waist circumference also attenuated the differences between those who ate takeaway once a week or less and those who ate takeaway twice a week or more (insulin 6.41 versus 6.39mU/L respectively, P=0.937; HOMA 1.47 versus 1.46 respectively, P=0.818). There were no significant differences between the two takeaway food groups for total cholesterol, LDL or HDL cholesterol, blood pressure or metabolic syndrome score for men or women. Including BMI in the model instead of waist circumference did not change the strength or the significance of the associations.

When we adjusted for smoking status in Table 2, the difference in fasting insulin concentration for men was magnified (mean fasting insulin 6.09mU/L for men eating takeaway once a week or less versus 6.65mU/L for men eating takeaway twice a week or more; P=0.036) due to an unexpected negative association between smoking status and insulin. For women, adjusting for smoking status resulted in almost no change in the differences in glucose, insulin and HOMA.

After adjusting for confounders, the proportion of participants classified as having high triglycerides, total or LDL cholesterol, high blood pressure or hypertension was not significantly different between the two takeaway food groups for men or for women (Table 6.3).

Table 6.2a. Adjusted means (95% CI) for cardio-metabolic variables for men by takeaway food consumption

Cardio-metabolic variable	Overall			By takeaway food consumption[a]				
				≤1/week		≥2/week		
	n	Mean	95% CI	Mean	95% CI	Mean	95% CI	P-value
Triglycerides (mmol/L)	914	1.01	0.98, 1.05	1.00	0.95, 1.05	1.03	0.97, 1.09	0.464
Total cholesterol (mmol/L)	914	4.86	4.80, 4.92	4.85	4.77, 4.93	4.88	4.77, 4.98	0.689
LDL cholesterol (mmol/L)	903	3.02	2.97, 3.08	3.02	2.95, 3.09	3.03	2.94, 3.12	0.810
HDL cholesterol (mmol/L)	914	1.26	1.24, 1.28	1.27	1.25, 1.29	1.25	1.23, 1.28	0.412
Glucose (mmol/L)	912	5.14	5.11, 5.17	5.15	5.11, 5.18	5.13	5.09, 5.18	0.670
Insulin (mU/L)	911	6.28	6.04, 6.52	6.12	5.81, 6.43	6.53	6.13, 6.94	0.113
HOMA	910	1.44	1.38, 1.49	1.40	1.33, 1.48	1.49	1.39, 1.59	0.156
Systolic blood pressure (mmHg)	914	124.37	123.67, 125.06	124.78	123.89, 125.67	123.74	122.64, 124.84	0.152
Diastolic blood pressure (mmHg)	914	74.32	73.75, 74.89	74.35	73.62, 75.08	74.27	73.36, 75.19	0.901
Metabolic syndrome score	912	1.91	1.87, 1.96	1.89	1.83, 1.95	1.95	1.87, 2.02	0.241

HOMA, homeostasis model assessment.
[a] Adjusted for age, employment status, leisure time physical activity and TV viewing.

Table 6.2b. Adjusted means (95% CI) for cardio-metabolic variables for women by takeaway food consumption

Cardio-metabolic variable	Overall			By takeaway food consumption[a]				
				≤1/week		≥2/week		
	n	Mean	95% CI	Mean	95% CI	Mean	95% CI	P-value
Triglycerides (mmol/L)	982	0.81	0.79, 0.84	0.81	0.78, 0.84	0.82	0.76, 0.88	0.815
Total cholesterol (mmol/L)	982	4.71	4.66, 4.77	4.72	4.66, 4.78	4.68	4.56, 4.80	0.540
LDL cholesterol (mmol/L)	979	2.74	2.69, 2.78	2.74	2.68, 2.77	2.73	2.63, 2.84	0.976
HDL cholesterol (mmol/L)	982	1.51	1.49, 1.53	1.51	1.49, 1.54	1.48	1.43, 1.52	0.129
Glucose (mmol/L)[b]	981	4.83	4.81, 4.85	**4.82**	**4.79, 4.84**	**4.88**	**4.82, 4.93**	**0.045**
Insulin (mU/L)	979	6.05	5.85, 6.25	5.95	5.73, 6.17	6.45	5.98, 6.93	0.054
HOMA	979	1.30	1.25, 1.34	**1.27**	**1.22, 1.32**	**1.40**	**1.29, 1.51**	**0.034**
Systolic blood pressure (mmHg)	978	110.37	109.76, 110.98	110.60	109.91, 111.29	109.47	108.12, 110.83	0.152
Diastolic blood pressure (mmHg)	978	69.81	69.28, 70.33	69.78	69.19, 70.36	69.92	68.74, 71.11	0.828
Metabolic syndrome score	978	2.58	2.54, 2.93	2.57	2.52, 2.62	2.66	2.56, 2.76	0.109

HOMA, homeostasis model assessment.

[a] Adjusted for age, employment status, leisure time physical activity and TV viewing.

[b] One women with an influentially low fasting glucose value (1.6mmol/L) was excluded from the analysis of fasting glucose and HOMA.

Table 6.3. Prevalence ratios of adverse lipids and blood pressure for frequency of takeaway food consumption

Frequency of takeaway food consumption	Men (N=914)					Women (N=982)				
		Unadjusted		Adjusted[b]			Unadjusted		Adjusted[b]	
	n (%)[a]	PR	95% CI	PR	95% CI	n (%)[a]	PR	95% CI	PR	95% CI
Triglycerides (≥2.26mmol/L)										
≤1/week	50 (9.0)	1.00		1.00		21 (2.7)	1.00		1.00	
≥2/week	41 (11.5)	1.28	0.87, 1.89	1.24	0.83, 1.86	3 (1.5)	0.60	0.17, 1.89	0.50	0.16, 1.62
Total cholesterol (≥6.22mmol/L)										
≤1/week	61 (11.0)	1.00		1.00		38 (4.8)	1.00		1.00	
≥2/week	39 (10.9)	1.00	0.68, 1.46	1.05	0.72, 1.53	6 (3.1)	0.93	0.27, 1.47	0.59	0.25, 1.41
LDL cholesterol (≥4.14mmol/L)										
≤1/week	61 (11.1)	1.00		1.00		31 (4.0)	1.00		1.00	
≥2/week	38 (10.7)	0.96	0.66, 1.41	0.99	0.67, 1.44	11 (5.6)	1.41	0.72, 2.75	1.47	0.74, 2.92
HDL cholesterol (≤1.1mmol/L)										
≤1/week	94 (16.9)	1.00		1.00		34 (4.3)	1.00		1.00	
≥2/week	72 (20.2)	1.20	0.91, 1.58	1.19	0.90, 1.58	16 (8.1)	**1.88**	**1.06, 3.33**	1.79	0.98, 3.26
High blood pressure[c]										
≤1/week	325 (58.4)	1.00		1.00		156 (20.0)	1.00		1.00	
≥2/week	203 (56.9)	0.97	0.87, 1.09	0.97	0.87, 1.09	41 (20.9)	1.05	0.77, 1.42	1.01	0.74, 1.37
Hypertension[d]										
≤1/week	70 (12.6)	1.00		1.00		30 (2.8)	1.00		1.00	
≥2/week	44 (12.3)	0.98	0.69, 1.40	0.96	0.68, 1.37	5 (2.6)	0.66	0.26, 1.70	0.69	0.28, 1.71

[a] Number (%) of participants with adverse lipids or blood pressure.
[b] Analyses adjusted for age, employment status, leisure time physical activity and TV viewing.
[c] High blood pressure: systolic ≥120mmHg and <140mmHg or diastolic ≥80mmHg and <90mmHg.
[d] Hypertension: systolic ≥140mmHg or diastolic ≥90mmHg or taking blood pressure lowering medication.

6.5 Discussion

In this sample of Australian adults, the majority of participants reported eating takeaway food once a week or less, which is consistent with other recent Australian studies (27, 28). Women who ate takeaway food twice a week or more had higher fasting glucose and insulin concentrations and higher HOMA insulin sensitivity scores than those who ate takeaway once a week or less. Adjustment for waist circumference or BMI attenuated these associations which suggest the effect of takeaway food consumption on these risk factors was in part mediated by obesity.

Although the differences between the two takeaway food groups for fasting glucose and HOMA were statistically significant for women, the differences were small and it is unclear whether the differences are clinically significant. However, they may represent early impaired insulin sensitivity. If so, they foreshadow increased risk of CVD and type 2 diabetes because previous epidemiological studies have shown insulin resistance and fasting insulin is positively associated with risk of coronary heart disease (29, 30).

In this sample of young adults, women appeared to have a better metabolic profile than men irrespective of takeaway food consumption. This is consistent with our previous analysis in this cohort that suggested women were more likely than men to meet dietary recommendations for breads and cereals, vegetables, fruit and lean meat and alternatives (7). In this study, differences between women and men were most pronounced among those who ate takeaway food once a week or less, and our previous results showed those who ate takeaway more frequently had poorer diet quality.

Our results that frequent takeaway food consumption was associated with insulin resistance for women, and less convincingly for men, is consistent with the findings from the CARDIA study (2, 4). The CARDIA study did not report associations separately by sex. We found no association between takeaway food consumption and fasting lipid concentrations. In contrast, participants in the CARDIA study who ate fast food regularly had higher triglyceride concentrations and lower HDL concentrations (2). The CARDIA participants were older (38-50 years old at the 20 year follow-up) than those in the CDAH study and this may explain the differences in the results. CVD risk factors are generally more common in older age groups and older participants may have increased exposure through longer established takeaway consumption habits. It is possible the effect of takeaway food consumption is shown early in glucose control, but a longer time frame is needed for the effect to be shown in lipids. In addition, the CARDIA study only examined associations with consumption of fast food from chain stores whereas in the present study we also included other common takeaway food items.

Takeaway food consumption was not associated with the metabolic syndrome score. The lack of association may be due to the young and relatively healthy study population. However, because the score is continuous we would expect it to be more sensitive to differences between the two takeaway food groups than a score based on dichotomous variables where few people have reached the cut points. Waist circumference and fasting glucose were the only components of the metabolic syndrome score that were found to be associated with takeaway food consumption in this sample.

We found no association between takeaway food consumption and blood pressure. Blood pressure increases with age and in our sample of young adults there was a restricted range of values. This may have reduced our ability to detect the effect of takeaway food consumption on blood pressure. It is possible that associations between takeaway food consumption and blood pressure may be detected in later years when more variability in blood pressure exists and when takeaway food habits have been longer established.

There are several limitations of this study. Due to the cross-sectional design, we are unable to determine the direction of a causal relationship between takeaway food consumption and cardio-metabolic risk in women. However, two longitudinal studies have shown that frequent fast food consumption at baseline is positively associated with cardio-metabolic risk factors 13 and 15 years later (2, 4). The large loss to follow-up and the proportion of participants excluded from the analyses due to missing data is a potential limitation of this study. Whilst we cannot discount the possibility of differential bias due to lose to follow-up, we have at least retained heterogeneity in the distribution of study factors and this is an important factor in respect to external validity of analytical findings. High levels of takeaway food consumption were not very common in our sample and we were unable to examine a dose-response relationship due to the small number of participants who were eating takeaway food three or more times per week. Our takeaway food question only asked about hot takeaway food and excludes cold items such as sandwiches, salads or other snack foods like doughnuts, muffins and pastries. In addition, we do not have data on the quality of the takeaway food consumed. Some participants might have chosen healthier items from the takeaway menus, and this would reduce the strength of the associations observed. The nutrient composition of Chinese and Thai foods would also be different to that of foods purchased from the main fast food chains, such as hamburgers and french fries, in their composition of trans fatty acids, vitamins and antioxidants. Further studies that compare the effects on cardio-metabolic risk factors of items from fast food chains with other takeout options would be useful. We did not have a measure for energy intake. However, stratifying the analysis by sex and adjusting for age and physical activity would have partially accounted for energy intake.

Strengths of this study include its assessment of *usual* takeaway food consumption and the inclusion of popular takeaway food items such as Indian and Chinese foods as well as food typically purchased from the main fast food chains. Other strengths include the large national sample and measures of a wide range of socio-demographic and lifestyle factors that we were able to include in our models to reduce possible confounding. The present study is one of the few studies to examine associations between takeaway food consumption and biochemical cardio-metabolic risk factors and the only study to examine whether associations are mediated by obesity.

6.6 Conclusion

Consuming takeaway food at least twice a week was associated with cardio-metabolic risk factors, particularly fasting glucose and HOMA score for women in this sample, and the results suggest the effect was mediated by obesity.

6.7 Postscript

The research presented in this chapter demonstrated that consuming takeaway food at least twice a week was associated with cardio-metabolic risk factors in women but less so in men. The effect of takeaway food consumption was attenuated when adjusting for waist circumference or BMI, suggesting the effect is mediated by obesity.

The eating behaviour examined in Chapter 5 and Chapter 6 investigated takeaway food consumption, a behaviour relating to types of food consumed. The research presented in the next chapter examines how often participants eat and whether the number of times young adults eat per day is associated with diet quality and cardio-metabolic risk factors.

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Chapter 7. Daily eating frequency and cardio-metabolic risk factors in young Australian adults: cross-sectional analyses

7.1 Preface

The research presented in the previous two chapters showed takeaway food consumption was associated with abdominal obesity for men and women and cardio-metabolic risk factors for women. Eating frequency may also be important in the development of overweight, obesity and other cardio-metabolic risk factors. However the evidence is inconsistent. This chapter examines whether eating frequency is associated with diet quality, abdominal obesity and cardio-metabolic risk factors in young Australian adults. The text from this chapter was accepted for publication by the British Journal of Nutrition on the 24/10/2011.

7.2 Introduction

There is some evidence that in recent decades individuals have moved away from eating three meals per days to eating more frequently. Data from large nationally representative surveys suggest adults in the USA are consuming foods more frequently throughout the day than 30 years ago (1). Between 1977-1978 and 2003-2006 the median number of eating occasions increased from 3.5 times per day to 5 times per day.

Over the same time period the prevalence of overweight and obesity has also increased, which raises the question of whether increased eating frequency is associated with adiposity. Some early epidemiological studies reported an inverse association between eating frequency and body weight (2), however, more recent epidemiological studies suggest the inverse association was a result of reporting bias (3). Several (4, 5), but not all (6, 7), studies that exclude under reporters and/or adjust for physical activity have shown the inverse association disappears. A review of weight loss and weight maintenance trials reported no benefit of a higher eating frequency on weight loss (8). There is some evidence that increased eating frequency is associated with greater appetite control (9, 10), and this may result in reduced total energy intake and weight loss. Randomised controlled trials examining the effect of eating frequency on body weight have controlled energy intake which would prevent investigation of this causal pathway.

In addition to adiposity, eating frequency has also been reported to be associated with other cardio-metabolic risk factors. A recent review of eight randomized cross-over trials investigated which meal pattern, “feasting” (consuming all daily energy needs in one large meal each day) or “nibbling” (eating several small meals over a day), was best for cardiovascular disease (CVD) prevention (11).

The authors reported a weak dose-response relationship, with a reduction in total and LDL cholesterol concentrations as the number of meals consumed per day increased and concluded six or more meals per day may reduce the risk of CVD in non-diabetic, normal weight and obese individuals. Trials examining the effect of eating frequency on glucose metabolism have reported mixed results, showing either a beneficial effect or no association (8).

It is not clear what effect eating frequency has on cardio-metabolic risk factors when food is consumed *ad libitum*. In addition, it is unclear whether findings from controlled trials can be generalised to population settings.

The aims of this study were to determine whether eating frequency was associated with cardio-metabolic risk factors in a national sample of young adults, and to determine whether any associations were confounded by physical activity or mediated by diet quality or waist circumference.

7.3 Methods

The Childhood Determinants of Adult Health (CDAH) study is a follow-up of children who participated in the 1985 Australian Schools Health and Fitness Survey (ASHFS), a nationally representative study of 8,498 children aged 7-15 years (12). During 2001-2002, 6,840 (80%) participants were traced and 5,170 (76%) were enrolled in the CDAH study. Participants were invited to attend one of 34 study clinics held in each state and territory of Australia. The clinics included a range of physical measures including anthropometric measurements and the collection of a fasting blood sample and were attended by 2,410 participants (aged 26-36 years) during 2004-2006. Questionnaires were completed to collect data on demographics, diet and physical activity. Participants gave informed written consent and the study was approved by the Southern Tasmanian Health and Medical Research Ethics Committee.

7.3.1 Dietary assessment

Diet was assessed using a meal patterns chart, a food frequency questionnaire (FFQ) and a food habits questionnaire. The meal patterns chart divided the day into hourly intervals from 6am to 11pm and the hours 11pm to 6am were combined as a single time period. Participants were asked to think back to the previous day and for each interval participants were asked “Did you eat anything?” Response options were “no”, “a snack”, “a small meal” or “a large meal”. Examples of each meal type were given. Information on drinks consumed was also collected, however, drinks consumed on their own were not included as eating occasions (4). A similar method for measuring meal patterns has been used in a previous study of adults (13). In that study a subsample of participants completed the meal patterns chart a second time three months later and showed good retest reliability (13).

The FFQ included 127 food and beverages. Participants were asked to estimate how many times in the previous 12 months they had consumed each item using one of six response options ranging from “never/less than once per month” to “6+ times per day”. The questionnaire did not collect information on serving sizes. Participants who did not answer at least 90% of the FFQ were excluded from the analyses. Daily serves of breads and cereals, dairy, lean meat and alternatives, and extra foods (those that do not fit into the five core food groups) were calculated (14). The FFQ was a modified version of one previously used in the 1995 Australian National Nutrition Survey (15-18) and was based on an existing FFQ developed for Australian populations (19) but has not been validated with weighed food records.

The food habits questionnaire asked short questions about food related behaviours. Usual daily intakes of fruit and vegetables were estimated using the questions “How many serves of fruit do you usually eat each day?” and “How many serves of vegetables (excluding potatoes) do you usually eat each day?” Short questions have been shown to be a valid method of assessing fruit and vegetable intake (20). Participants were asked if they were currently following a special diet (vegetarian, weight reduction, diabetic, fat modified, other, no special way of eating).

Diet quality was assessed by comparing participants’ dietary intake with the age and sex-specific recommendations in the Australian Guide to Health Eating (21). Daily serves of breads and cereals, dairy, lean meat and alternatives, and extra foods were calculated (14). To calculate the overall dietary score, points were given for each component of the diet for which recommended intake was achieved (score range 0-6).

7.3.2 Anthropometric measurements

For the anthropometric measurements participants were standing, wearing light clothing and no shoes. All technicians were trained by the same anthropometrist and followed standardised protocols. Waist circumference was measured three times using a Lufkin steel (non-stretch) tape measure at the narrowest point between the lower costal border and the iliac crest at the end of normal expiration. The mean value was used for the analysis. Body weight was measured using a Heine portable scale (Heine, Dover, NH) and height was measured using a portable stadiometer (Invicta, Leicester, United Kingdom). BMI (kg/m^2) was calculated.

7.3.3 Blood chemistry

Venous blood samples were collected from the antecubital vein after an overnight fast. Fasting glucose, triglycerides, total cholesterol and HDL cholesterol concentrations were determined enzymatically using an Olympus AU5400 automated analyzer (Olympus Optical, Tokyo, Japan). LDL cholesterol concentration was calculated using the Friedewald formula (22). Fasting insulin concentration was determined using two methods: a microparticle-enzyme immunoassay kit (AxSYM; Abbot Labatories, Abbot Park, IL) and electrochemiluminescence immunoassay (Elecsys

Modular Analytic E170; Roche Diagnostics, Mannheim, Switzerland). A correction factor of 0.81 was applied to the insulin values assessed with the microparticle-enzyme immunoassay. Insulin sensitivity was estimated by the homeostasis model assessment (HOMA) index ((fasting serum insulin (U/mL) x fasting glucose (mmol/L))/22.5).

7.3.4 Blood pressure

Blood pressure was measured three times with a digital automatic monitor (Omron HEM907; Omron Health Care Inc, Kyoto, Japan). The mean value was used in the analyses.

7.3.5 Continuous metabolic syndrome score

A continuous metabolic syndrome score was created using the methods described by Wijndaele et al (23, 24).

7.3.6 Covariates

Demographic variables were self-reported and included age, marital status (married or living as married, other), highest level of education (school only, vocational, university), occupation (professional or manager, non-manual, manual, not in the workforce), smoking status (never, former, current smoker) and parity (0, 1, 2, 3+). Parity was considered as a confounder because we thought women with children may be more likely to be overweight or obese and having children may result in a more regular eating pattern. However, parity was not found to be a significant confounder and was not included in the final models. Leisure time physical activity and time spent sitting were assessed using the long version of the International Physical Activity Questionnaire (25). Participants also wore a pedometer (Yamax Digiwalker SW 200) for seven days. The average number of daily steps was calculated for participants who reported wearing the pedometer for at least eight hours on at least four days. Time spent watching TV was also assessed (26). Weekly alcohol consumption was estimated from nine alcoholic beverages in the FFQ and their average alcohol concentration (27).

7.3.7 Statistical analyses

The mean (SD) number of each meal and snack type and the overall number of eating occasions were calculated. The number of eating occasions was collapsed into six categories (1-2, 3, 4, 5, 6 and 7+ times per day) due to the small number of people who were eating once or twice a day and those who were eating seven or more times. We chose not to group the eating frequency into groups such as “nibbling”, “grazing” or “gorging” as others have done (11, 28-32) because there is no consistency in the definition of these categories and no evidence in our data of threshold values that would support any such categorisation. A test of trend in the mean number of each meal type with eating frequency was estimated using a Poisson regression model. A test of trend in proportions meeting the dietary recommendations was estimated with a log binomial regression model. In each case, the

P-value reported is a test of significance of the coefficient of a linear predictor taking values equal to the mean number of eating occasions in each category (the mean for category 1-2 was 1.88 times per day and the mean for category 7+ was 7.52 times per day).

Associations between eating frequency and cardio-metabolic risk factors were estimated using linear regression. The cardio-metabolic variables were transformed as required to reduce skewness, but all estimates are reported in the original units. Covariates added to the model were those that were associated with the outcome, were not intermediates between the exposure and the outcome and, when included in the model, changed the coefficient of the variable for the principal study factor by at least 10% (33). Participants who were missing information for covariates were excluded from the analyses presented in Table 4. Excluding these participants (101 men and 76 women) from the data reported in Tables 1-3 made almost no difference to those results. Model 1 included age, education and, for women, alcohol intake. LTPA was added to Model 2. To examine if any associations were mediated by diet quality, Model 3 included additional adjustments for the overall dietary score. Model 4 included adjustment for waist circumference. The effect of one additional eating occasion on cardio-metabolic risk factors was calculated at the mean values of the other covariates.

Pregnant women (n=78) were excluded from all analyses. The analyses were repeated excluding individuals who reported they were on a weight loss diet (29 men and 117 women) or were taking diabetes medication (6 men and 8 women). Data for men and women were analysed separately. All statistical analyses were conducted using STATA software (version 10.1, 2009 Statacorp, College Station, Texas).

7.4 Results

In total 1,275 men and 1,580 women completed the meal patterns chart. The socio-demographic and lifestyle characteristics of the participants are shown in Table 7.1. Compared to the Australian population of 25-34 year olds, the CDAH sample had a higher percentage who were married or living as married (57% of men and 64% of women in the Australian population) and a higher percentage who were employed as professionals or managers (40% of men and 38% of women in the Australian population). The percentage classified as being overweight or obese (BMI ≥25kg/m^2) was very similar to the Australian population (58% of men and 35% of women).

7.4.1 Eating frequency

Men reported eating between one and 14 times per day (Figure 7.1). Most men reported eating three (24.3%), four (27.3%) or five (22.1%) times per day. For women, the number of eating occasions ranged from one to 11 times per day, and most reported eating four (23.8%), five (29.0%) or six (20.2%) times per day.

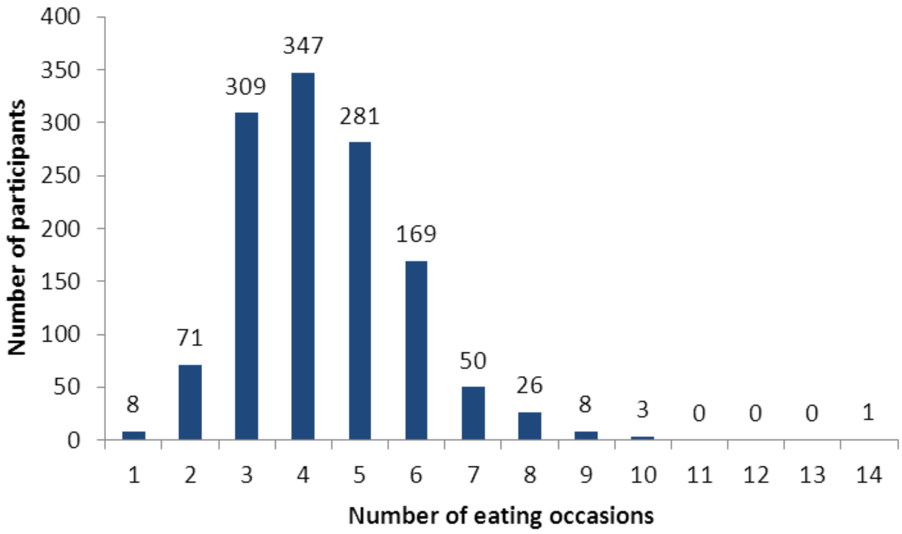
Table 7.1. Socio-demographic and lifestyle characteristics of the participants

	Men (N=1273)		Women (N=1502)	
Socio-demographic/lifestyle factor	n	%	n	%
Age (mean, SD)	31.68	2.57	31.50	2.63
Marital status (n, %)				
Single	421	33.1	438	29.2
Married or living as married	852	66.9	1063	70.8
Education (n, %)				
University	437	37.3	671	44.7
Vocational	455	35.9	388	25.9
No post-secondary education	341	26.9	441	29.4
Occupation (n, %)				
Professional or manager	717	57.1	714	48.4
Non-manual	95	7.6	398	27.0
Manual	398	31.7	74	5.0
Not in workforce	45	3.6	288	19.5
Leisure time physical activity (mean, SD)				
Minutes/week	174.43	222.11	156.12	184.95
Steps (mean, SD)				
Steps/day	9239.0	3560.4	8893.4	3064.2
TV viewing (mean, SD)				
Hours/week	11.4	13.5	9.6	10.7
Parity (n, %)				
0			119	17.7
1			185	27.5
2			259	38.5
3+			109	16.2

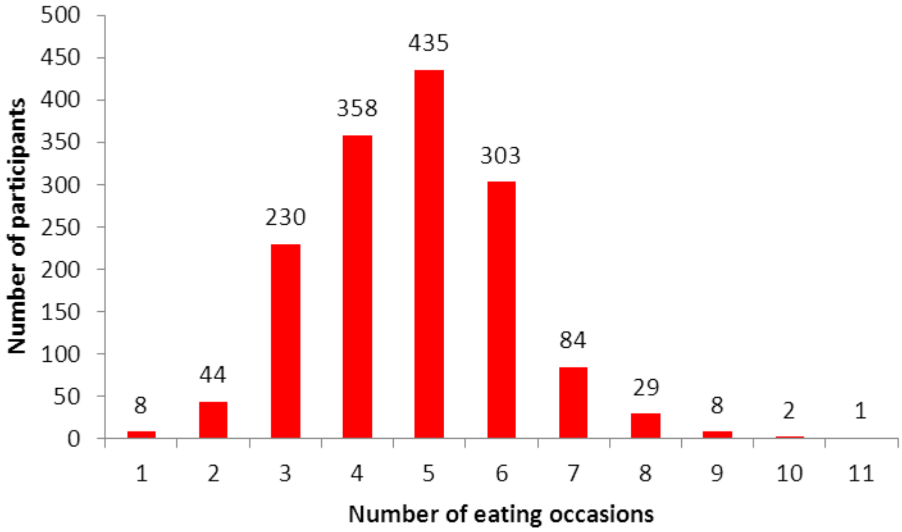
Due to some missing data, numbers do not always add up 1,273 for men and 1,502 for women.

Figure 7.1. Number of eating occasions men and women reported during the previous day

A Men (N=1,273)



B Women (N=1,502)



7.4.2 Meal types and diet quality

The mean number of all three meal types (large meals, small meals and snacks) increased with the number of eating occasions for both men and women (P<0.05, Table 7.2). Snacks were the greatest single contributor when eating more than four times per day.

Table 7.2. Mean (SD) number of meals and snacks by number of eating occasions

Number of eating		Large meals		Small meals		Snacks	
occasions	n	Mean	SD	Mean	SD	Mean	SD
Men (n=1273)							
1-2	79	0.97	(0.62)	0.66	(0.62)	0.27	(0.44)
3	309	1.18	(0.64)	1.28	(0.76)	0.54	(0.66)
4	347	1.18	(0.64)	1.57	(0.86)	1.25	(0.67)
5	281	1.27	(0.69)	1.70	(0.92)	2.03	(0.74)
6	169	1.37	(0.82)	1.78	(1.02)	2.85	(0.94)
7+	88	1.13	(0.74)	2.23	(1.11)	4.31	(1.58)
Linear trend			***P=0.043***		***P<0.001***		***P<0.001***
Women (n=1502)							
1-2	52	0.63	(0.66)	0.88	(0.70)	0.33	(0.51)
3	230	0.90	(0.63)	1.46	(0.76)	0.65	(0.69)
4	358	0.92	(0.57)	1.66	(0.74)	1.42	(0.63)
5	435	0.97	(0.58)	1.86	(0.72)	2.17	(0.56)
6	303	0.99	(0.60)	1.94	(0.81)	3.07	(0.53)
7+	124	0.93	(0.68)	2.15	(0.83)	4.36	(1.01)
Linear trend			***P=0.011***		***P<0.001***		***P<0.001***

As the number of eating occasions increased the percentage of participants meeting the dietary recommendations increased, with the exception of breads and cereals and extra foods for men and vegetables and extra foods for women (Table 7.3). The mean dietary score also increased as number of eating occasions increased for both men and women.

Table 7.3. Number (%) of participants meeting the recommended number of daily serves for each food group by eating frequency

	Number of eating occasions												
Food group[a]	1-2		3		4		5		6		7+		Trend in proportions
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	
Men	N=75		N=298		N=339		N=270		N=166		N=85		
Breads and cereals (6-12)	1	(1.3)	13	(4.2)	15	(4.3)	10	(3.6)	12	(7.1)	6	(6.8)	P=0.059
Vegetables (5) [b]	4	(5.1)	15	(4.9)	26	(7.5)	25	(8.9)	9	(5.3)	12	(13.6)	**P=0.022**
Fruit (2) [b]	17	(21.8)	94	(30.7)	127	(36.6)	115	(41.1)	82	(48.5)	54	(61.4)	**P<0.001**
Dairy (2)	22	(27.9)	93	(30.1)	129	(37.2)	121	(43.1)	71	(42.0)	45	(51.1)	**P<0.001**
Lean meat and alternatives (1)	56	(70.9)	240	(77.7)	278	(80.1)	133	(82.9)	144	(85.2)	77	(87.5)	**P<0.001**
Extra foods (0-3)	11	(14.7)	17	(5.7)	16	(4.7)	11	(4.1)	15	(9.0)	5	(5.9)	P=0.474
Mean (SD) dietary score [c]	1.41	(0.82)	1.55	(0.96)	1.71	(1.01)	1.86	(1.02)	1.97	(1.09)	2.26	(0.98)	**P<0.001**
Women	N=50		N=222		N=339		N=420		N=292		N=121		
Breads and cereals (4-9)	2	(3.9)	30	(13.0)	47	(13.1)	79	(18.2)	63	(20.8)	31	(25.0)	**P=0.001**
Vegetables (5) [b]	5	(9.6)	28	(12.2)	47	(13.2)	56	(12.9)	44	(14.6)	13	(10.5)	P=0.770
Fruit (3) [b]	10	(19.2)	79	(34.5)	159	(44.5)	233	(53.7)	176	(58.1)	75	(60.5)	**P<0.001**
Dairy (2)	15	(28.9)	63	(27.4)	97	(27.1)	181	(41.6)	143	(47.2)	66	(53.2)	**P<0.001**
Lean meat and alternatives (2)	42	(80.8)	191	(83.0)	310	(86.6)	396	(91.0)	276	(91.1)	108	(87.1)	**P=0.010**
Extra foods (1-2½)	4	(8.0)	14	(6.3)	22	(6.5)	19	(4.5)	17	(5.8)	5	(4.1)	P=0.257
Mean (SD) dietary score [c]	1.54	(0.86)	1.77	(1.03)	1.91	(1.04)	2.21	(1.08)	2.39	(1.13)	2.40	(1.16)	**P<0.001**

[a] Daily Dietary Recommendations for Australian Adults aged 19-60 are presented in the table in parentheses' after each food group. Participants consuming at least the lower value for breads and cereals and not exceeding the upper limit for extra foods were classified as meeting the recommendation. Participants classified as meeting the vegetable recommendation were consuming 4-5 serves/day.
[b] Some men and women did not answer the fruit and vegetable questions therefore there is some missing data: men eating 3 times/day n=296 for vegetables and 295 for fruit; men eating 5 times/day n=269 for fruit and for vegetables; women eating 4 times/day n=338 for fruit and for vegetable; women eating 5 times/day n=419 for fruit; women eating 6 times/day n=291 vegetables.
[c] To calculate the dietary score, points were given for each component of the diet for which recommended intake was achieved (score range 0-6).

7.4.3 cardio-metabolic risk factors

For men, the mean values for cardio-metabolic risk factors tended to decrease with increased eating frequency (the exceptions were HDL cholesterol and blood pressure Table 7.4a). For women, the only significant trend was for total cholesterol (Table 7.4b).

The coefficients reported in Tables 7.5a and 7.5b are estimates of the difference in cardio-metabolic risk factors associated with one additional eating occasion calculated at the mean number of eating occasions (4.39 times per day for men and 4.75 times per day for women). Generally the associations between eating frequency and cardio-metabolic risk factors were not changed by adjusting for LTPA (Model 2). Additional adjustments for diet quality tended to reduce the magnitude of the associations but the statistical significance did not change (Model 3). Further adjustment for waist circumference attenuated the associations for men, particularly for triglycerides, insulin and HOMA (Model 4). After adjustment, the negative association between HDL cholesterol and eating occasions for men became statistically significant because the presence of additional covariates in the model reduced the standard error of the coefficient for eating occasions.

For men there was a eating frequency-education interaction for BMI and an eating frequency-age interaction for HDL, where lower education and older age increased the effect of eating frequency. For women there were eating frequency-education interactions for waist circumference, BMI, fasting glucose, HOMA, HDL cholesterol and metabolic syndrome score. Where a lower education increased the effect of eating frequency except for HDL where lower education reduced the effect of eating frequency. The magnitude of effect of these interactions in each case was small for most participants.

The strength and significance of the associations did not change when the analyses were repeated in the subsample of participants who had pedometer (steps) data or when those who reported they were on a weight loss diet or were taking diabetes medication were excluded from the analyses.

Table 7.4a. Mean (SD) cardio-metabolic values for men by number of eating occasions

Cardio-metabolic variable	Number of eating occasions: 1-2		3		4		5		6		7+		Linear trend
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	
Waist circumference (cm)	90.08	(11.01)	88.62	(9.99)	88.59	(10.61)	87.56	(9.08)	86.69	(9.33)	85.31	(8.53)	**P <0.001**
BMI (kg/m^2)	26.67	(4.22)	25.99	(4.05)	26.02	(4.15)	25.84	(3.63)	25.43	(3.80)	24.78	(3.28)	**P=0.002**
Fasting glucose (mmol/L)	5.20	(0.48)	5.14	(0.41)	5.13	(0.45)	5.11	(0.48)	5.07	(0.42)	5.07	(0.44)	**P=0.033**
Fasting insulin (mU/L)	6.89	(5.25)	6.81	(4.34)	6.34	(3.98)	6.37	(3.69)	5.75	(3.66)	4.92	(3.13)	**P<0.001**
HOMA	1.60	(1.32)	1.56	(1.05)	1.45	(0.99)	1.45	(0.90)	1.30	(0.87)	1.11	(0.75)	**P<0.001**
Triglycerides (mmol/L)	1.06	(0.70)	1.05	(0.65)	1.07	(0.65)	1.03	(0.61)	0.92	(0.67)	0.92	(0.63)	**P=0.013**
Total cholesterol (mmol/L)	5.10	(1.04)	4.91	(1.03)	4.98	(0.98)	4.80	(0.98)	4.75	(1.01)	4.60	(0.96)	**P=0.001**
LDL cholesterol (mmol/L)	3.26	(0.88)	3.03	(0.87)	3.10	(0.81)	3.01	(0.85)	2.91	(0.89)	2.81	(0.80)	**P=0.002**
HDL cholesterol (mmol/L)	1.23	(0.25)	1.28	(0.26)	1.28	(0.26)	1.24	(0.24)	1.29	(0.27)	1.26	(0.27)	P=0.843
Systolic blood pressure (mmHg)	124.06	(10.26)	124.41	(9.75)	124.29	(11.39)	123.91	(10.85)	124.73	(10.56)	126.25	(11.25)	P=0.308
Diastolic blood pressure (mmHg)	75.24	(8.45)	75.02	(8.62)	74.91	(8.68)	73.12	(9.11)	74.30	(8.33)	73.88	(9.81)	P=0.088
Metabolic syndrome score	0.10	(0.75)	0.00	(0.68)	-0.01	(0.76)	-0.06	(0.67)	-0.18	(0.73)	-0.18	(0.71)	**P=0.002**

Due to some participants not having measurements for all cardio-metabolic risk factors the sample sizes vary. For men eating: 1-2/day n=62-67; 3/day n=237-255; 4/day n=273-284; 5/day n=232-248; 6/day n=140-146; 7+/day n=77-80.

Table 7.4b. Mean (SD) cardio-metabolic values for women by number of eating occasions

Cardio-metabolic variable	Number of eating occasions												Linear trend
	1-2		3		4		5		6		7+		
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	
Waist circumference (cm)	76.80	(12.13)	77.24	(9.90)	75.55	(9.36)	74.88	(8.58)	75.82	(10.53)	76.52	(10.23)	P=0.348
BMI (kg/m^2)	24.60	(4.71)	24.49	(4.45)	23.68	(4.27)	23.63	(3.66)	24.09	(4.76)	23.60	(4.53)	P=0.162
Fasting glucose (mmol/L)	4.91	(0.45)	4.88	(0.37)	4.80	(0.38)	4.79	(0.39)	4.85	(0.40)	4.77	(0.42)	P=0.104
Fasting insulin (mU/L)	6.78	(4.23)	4.66	(3.77)	5.91	(3.20)	5.59	(3.07)	6.25	(3.41)	5.82	(3.69)	P=0.162
HOMA	1.48	(1.00)	1.39	(0.85)	1.26	(0.72)	1.19	(0.69)	1.34	(0.79)	1.22	(0.85)	P=0.096
Triglycerides (mmol/L)	0.83	(0.49)	0.88	(0.45)	0.82	(0.46)	0.77	(0.40)	0.81	(0.40)	0.82	(0.40)	P=0.137
Total cholesterol (mmol/L)	4.83	(1.17)	4.73	(0.86)	4.80	(0.86)	4.68	(0.82)	4.58	(0.85)	4.69	(0.89)	**P=0.044**
LDL cholesterol (mmol/L)	2.76	(1.04)	2.76	(0.79)	2.79	(0.73)	2.68	(0.70)	2.66	(0.79)	2.72	(0.75)	P=0.176
HDL cholesterol (mmol/L)	1.53	(0.34)	1.46	(0.34)	1.55	(0.34)	1.56	(0.33)	1.46	(0.31)	1.50	(0.35)	P=0.648
Systolic blood pressure (mmHg)	110.67	(9.55)	110.05	(10.69)	110.34	(9.47)	110.53	(9.64)	109.95	(9.84)	110.66	(40.49)	P=0.909
Diastolic blood pressure (mmHg)	70.66	(8.21)	69.69	(9.05)	69.64	(8.02)	69.77	(7.86)	69.21	(8.95)	70.29	(9.12)	P=0.891
Metabolic syndrome score	0.08	(0.78)	0.13	(0.69)	-0.04	(0.69)	-0.11	(0.65)	0.02	(0.75)	-0.06	(0.87)	P=0.096

Due to some participants not having measurements for all cardio-metabolic risk factors the sample sizes vary. For women eating: 1-2/day n=37-42; 3/day n=166-182; 4/day n=24
276; 5/day n=301-324; 6/day n=202-218; 7+/day n=91-100.

Table 7.5a. The effect of one additional eating occasion (coefficients from regression) on cardio-metabolic risk factors for men

	Model 1		Model 2		Model 3		Model 4	
Cardio-metabolic risk factor	β	95% CI	β	95% CI	β	95% CI	β	95% CI
Waist circumference (cm)	**-0.77**	**-1.16, -0.37**	**-0.77**	**-1.16, -0.37**	**-0.72**	**-1.12, -0.31**	--	--
BMI (kg/m^2)	**-0.26**	**-0.42, -0.11**	**-0.28**	**-0.44, -0.12**	**-0.27**	**-0.43, -0.10**	--	--
Fasting glucose (mmol/L)	**-0.02**	**-0.04, -0.002**	**-0.02**	**-0.04, -0.002**	**-0.02**	**-0.04, -0.003**	**-0.02**	**-0.04, -0.001**
Fasting insulin (mU/L)	**-0.34**	**-0.50, -0.18**	**-0.32**	**-0.47, -0.16**	**-0.26**	**-0.42, -0.10**	-0.06	-0.19, 0.08
HOMA	**-0.08**	**-0.12, -0.05**	**-0.08**	**-0.12, -0.04**	**-0.07**	**-0.10, -0.03**	-0.02	-0.05, 0.01
Triglycerides (mmol/L)	**-0.03**	**-0.06, -0.01**	**-0.03**	**-0.06, -0.01**	**-0.03**	**-0.05, -0.001**	-0.004	-0.03, 0.02
Total cholesterol (mmol/L)	**-0.08**	**-0.12, -0.03**	**-0.07**	**-0.12, -0.03**	**-0.06**	**-0.10, -0.01**	-0.04	-0.09, 0.001
LDL cholesterol (mmol/L)	**-0.06**	**-0.10, -0.02**	**-0.05**	**-0.09, -0.02**	**-0.04**	**-0.08, -0.003**	-0.03	-0.07, 0.01
HDL cholesterol (mmol/L)	-0.001	-0.01, 0.01	-0.003	-0.01, 0.01	-0.004	-0.01, 0.01	**-0.01**	**-0.02, -0.001**
Systolic blood pressure (mmHg)	0.24	-0.22, 0.71	0.21	-0.26, 0.66	0.19	-0.29, 0.67	0.33	-0.14, 0.81
Diastolic blood pressure (mmHg)	-0.34	-0.72, 0.04	-0.36	-0.74, 0.02	-0.28	-0.67, 0.11	-0.08	-0.45, 0.30
Metabolic syndrome	**-0.05**	**-0.09, -0.02**	**-0.05**	**-0.08, -0.02**	**-0.04**	**-0.08, -0.01**	-0.001	-0.02, 0.02

Model 1: Analyses adjusted for age and education.
Model 2: Model 1 + leisure time physical activity.
Model 3: Model 2 + overall dietary score (number of Dietary Guidelines met).
Model 4: Model 3 + waist circumference.

Table 7.5b. The effect of one additional eating occasion (coefficients from regression) on cardio-metabolic risk factors for women

	Model 1		Model 2		Model 3		Model 4	
Cardio-metabolic risk factor	β	95% CI	β	95% CI	β	95% CI	β	95% CI
Waist circumference (cm)	-0.14	-0.53, 0.25	-0.12	-0.51, 0.27	-0.07	-0.47, 0.32	--	--
BMI (kg/m^2)	-0.11	-0.28, 0.06	-0.11	-0.28, 0.07	-0.08	-0.26, 0.09	--	--
Fasting glucose (mmol/L)	-0.01	-0.03, 0.002	-0.01	-0.03, 0.002	-0.01	-0.03, 0.004	-0.02	-0.03, 0.001
Fasting insulin (mU/L)	-0.10	-0.24, 0.04	-0.10	-0.24, 0.04	-0.06	-0.20, 0.08	-0.06	-0.19, 0.06
HOMA	-0.03	-0.06, 0.01	-0.03	-0.06, 0.005	-0.02	-0.05, 0.02	-0.02	-0.05, 0.01
Triglycerides (mmol/L)	-0.01	-0.03, 0.01	-0.01	-0.03, 0.01	-0.01	-0.03, 0.01	-0.01	-0.03, 0.01
Total cholesterol (mmol/L)	**-0.03**	**-0.07, -0.004**	-0.03	-0.07, 0.004	-0.02	-0.06, 0.01	-0.03	-0.07, 0.01
LDL cholesterol (mmol/L)	-0.02	-0.06, 0.01	-0.02	-0.06, 0.01	-0.02	-0.05, 0.02	-0.02	-0.06, 0.01
HDL cholesterol (mmol/L)	0.001	-0.01, 0.01	0.001	-0.01, 0.01	0.001	-0.01, 0.01	0.001	-0.01, 0.01
Systolic blood pressure (mmHg)	0.08	-0.36, 0.51	0.06	-0.38, 0.49	0.10	-0.34, 0.55	0.11	-0.33, 0.55
Diastolic blood pressure (mmHg)	-0.002	-0.38, 0.37	-0.01	-0.38, 0.37	-0.001	-0.38, 0.38	0.02	-0.35, 0.38
Metabolic syndrome	-0.03	-0.06, 0.01	-0.03	-0.06, 0.01	-0.02	-0.06, 0.01	-0.02	-0.04, 0.004

Model 1: analyses adjusted for age, education and alcohol intake.
Model 2: Model 1 + leisure time physical activity.
Model 3: Model 2 + overall dietary score (number of Dietary Guidelines met).
Model 4: Model 3 + waist circumference.

7.5 Discussion

In this sample of Australian adults there was a linear trend between eating frequency and cardio-metabolic risk factors in men, with those eating more frequently having the lowest cardio-metabolic risk. There were no significant trends for women. For men the effect on fasting insulin, HOMA and triglycerides appeared to be mediated by waist circumference. The association between eating frequency and fasting glucose was not explained by our measures of socio-economic or lifestyle factors, diet quality or waist circumference.

As the number of eating occasions increased diet quality improved. This indicates those who ate more often were not just snacking on "empty foods" but were choosing foods that contribute to a healthy diet.

For men there was a negative association between eating frequency and waist circumference and BMI. The associations remained significant after adjusting for age, education and physical activity and were attenuated after adjusting for diet quality. The clinical benefits of one additional eating occasion is uncertain though a meta-regression analysis of 15 prospective studies reported a 1cm increase in waist circumference was associated with a 2% increased risk of a cardiovascular event (34). We found no significant associations between eating frequency and adiposity for women. Similarly, two cross-sectional studies have reported a higher eating frequency is associated with leanness in men but not women, after excluding under-reporters and adjusting for physical activity (6, 7). Another cross-sectional study also reported no association between BMI and body composition measurements in premenopausal women after adjusting for physical activity (35). In contrast, in a study of premenopausal women eating frequency was association with a lower waist circumference after adjusting for physical activity and VO_{2max} (as a measure of fitness), but associations with BMI and other measures of adiposity were no longer significant (4).

Our results in men are consistent with previous epidemiological studies and randomised controlled trials that have reported that a higher eating frequency is associated with a better lipid profile. Compared to eating once or twice a day, eating at least four times per day has been shown to be cross-sectionally associated with lower total and LDL cholesterol levels in men and women aged 50-81 years (36). In a review of randomised cross-over trials a dose response relationship between eating frequency and total and LDL cholesterol has been reported (11), with clinically significantly reductions (>5% reduction) in total and LDL cholesterol observed when at least six meals were consumed per day. The beneficial effects of eating more frequently were not due to weight loss as there were no significant changes in body weight during these trials.

For men a higher eating frequency was associated with lower concentrations of fasting glucose, insulin and a lower HOMA score. The associations with fasting insulin and HOMA appear to be mediated by abdominal obesity, however abdominal obesity did not appear to explain the association with fasting glucose.

It is not clear why a higher eating frequency was associated with cardio-metabolic benefits for men but not for women. It is possible that women who ate more often were eating unhealthy snacks and under-reported these items in the FFQ. Another possible explanation is the different fat distribution patterns of young men and women. Men are more likely to store excess fat centrally whereas women store it peripherally. Central adiposity is more metabolically harmful than peripheral fat. If individuals with a lower eating frequency are more likely to store fat, then this may explain why a lower eating frequency was associated with cardio-metabolic risk factors only in men. Another cross-sectional study reported a higher eating frequency was associated with lower cholesterol levels in 50-89 year old men and women (36). After menopause women store more fat centrally (37) and this may explain why significant results were observed in the older women. Adjusting for obesity and fat distribution reduced the differences observed in that study.

There are several limitations with this study. Due to the cross-sectional analyses we are unable to determine the direction of the association. Overweight or obese participants may have reduced their eating frequency in an attempt to lose weight or not reported some eating occasions. However, excluding those on a weight loss diet did not change our results and as our participants were from a population-based sample and were not recruited for being overweight or obese there may be less post hoc changes in diet to reduce weight. The meal patterns chart was only completed for the previous day and this may not be representative of the participant's normal eating patterns. However, we expect that any misclassification would be random in nature and would not bias our results. National data from the USA shows the day to day variation in an individual's eating frequency (measured using one 24-hour recall and two day diet records) is relatively large compared with the between subject variation (38). This suggests multiple days are needed to measure an individual's eating frequency with precision. Nevertheless, we were able to find significant associations with data for only one day for men and similar, nonsignificant, associations for women. The FFQ did not collect information on portion size and therefore we were unable to adjust our analysis for energy intake. However, even if we had self-reported portion size as well as food frequency, our estimates of energy intake would be prone to measurement error. We did take into account key determinants of energy intake by stratifying the analysis by sex and adjusting for age and physical activity. We also adjusted for overall diet quality. However, residual confounding from energy intake cannot be ruled out and experimental studies are needed to determine whether the associations are mediated by energy intake.

Strengths include the large sample size and stratification of the analyses by men and women to observe sex differences. We were able to examine associations between eating frequency and a variety of cardio-metabolic risk factors. We had data on a large range of socio-demographic and lifestyle factors and dietary variables which we were able to include in our models to reduce the risk of confounding.

7.6 Conclusion

A higher eating frequency was associated with reduced cardio-metabolic risk factors in men. The associations were mostly mediated through waist circumference. Although there is some evidence individuals reduce energy intake at other eating occasions when snacking is sustained (39), if portion sizes and energy density of the meals are not reduced enough to compensate for the higher eating frequency, eating smaller meals more frequently may result in weight gain. Therefore, more studies are needed to investigate the effect of eating frequency on appetite and energy intake, before recommending a higher eating frequency.

7.7 Postscript

This chapter examined whether meal frequency was associated with diet quality and cardio-metabolic risk factors. The next chapter examines whether skipping a particular eating occasion, breakfast, is associated with diet quality and cardio-metabolic risk.

7.8 References

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Appendix 7.A Additional analyses

Socio-demographic and lifestyle factors associated with eating frequency

The socio-demographic and lifestyles characteristics of the participants, stratified by eating frequency, are shown in Table 7.A.1. A lower percentage of men and women who were single were eating three times per day compared to those who were married and a higher percentage of current smokers were eating three times per day compared to non-smokers. A lower percentage of participants who were university educated were eating one to three times per day compared to those who were less educated. A higher percentage of participants who had low LTPA levels were eating one to three times per day, and a higher percentage of men who had high levels of LTPA were eating seven or more times per day.

Table 7.A.1. Socio-demographic and lifestyle characteristics by number of eating occasions

Socio-demographic/ lifestyle factor	Number of eating occasions over the previous day							P-value
	N	1-2	3	4	5	6	7+	(χ^2 test)
Men								
Age (%)								
26-29y	287	7.3	22.3	26.5	23.0	12.5	8.4	
30-33y	605	5.8	25.3	27.1	23.6	13.1	5.1	
34-36y	381	6.0	24.2	28.1	18.9	14.2	8.7	0.450
Marital status (%)								
Single	421	8.8	27.8	25.4	19.7	12.1	6.2	
Married or living as married	852	4.9	22.5	28.2	23.2	13.9	7.3	**0.019**
Education (%)								
University	473	4.2	24.5	26.6	22.2	15.2	7.2	
Vocational	455	7.7	24.0	26.2	25.1	12.3	4.8	
School only	341	7.0	24.6	29.9	17.6	11.7	9.1	**0.045**
Occupation (%)								
Professional or manager	717	5.0	25.5	26.9	22.0	13.4	7.1	
Non-manual	95	3.2	21.1	29.5	21.1	19.0	6.3	
Manual	398	8.3	22.9	28.9	22.4	11.8	5.8	
Not in work force	45	4.4	17.8	24.4	24.4	13.3	15.6	**0.285**
Smoking status (%)								
Never	784	4.6	23.0	28.6	24.6	12.0	7.3	
Former	190	5.8	26.3	26.8	16.8	19.5	4.7	
Current	229	12.7	25.8	25.8	17.0	11.4	7.4	**<0.001**

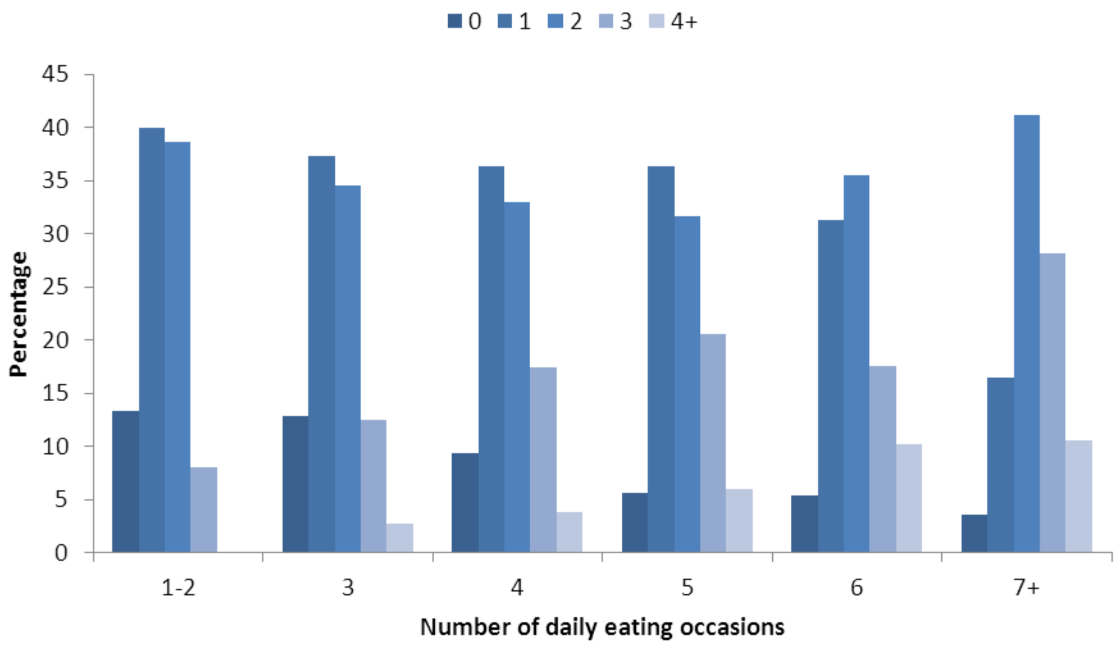
Leisure time physical activity (%)								
≤1 hour/week	492	8.3	26.6	27.9	20.7	10.6	5.9	
1.1-3.0 hour/week	284	4.9	24.7	25.0	25.0	14.1	6.4	
3.1-5.0 hour/week	170	3.5	19.4	27.1	26.5	17.7	5.9	
>5 hour/week	218	4.6	19.7	25.2	21.6	17.9	11.0	**0.012**
Television viewing (%)								
<8 hour/week	317	6.3	25.2	26.2	22.7	12.9	6.6	
8-14 hour/week	358	4.2	22.9	28.8	25.4	12.0	6.7	
15-21 hour/week	271	7.8	26.6	23.3	20.7	14.4	7.4	
>21 hour/week	209	6.7	20.1	26.8	21.5	17.2	7.7	0.627
Women								
Age (%)								
26-29y	398	2.3	15.8	25.1	27.1	20.4	9.3	
30-33y	681	2.8	14.2	23.5	28.9	21.7	8.8	
34-36y	423	5.7	16.6	23.2	30.7	17.5	6.4	0.107
Marital status (%)								
Single	438	4.1	20.3	22.2	26.3	19.0	8.2	
Married or living as married	1063	3.2	13.3	24.6	30.1	20.7	8.2	**0.018**
Education (%)								
University	671	1.8	13.6	23.3	30.9	20.9	9.7	
Vocational	388	4.9	16.8	26.3	25.3	19.9	7.0	
School only	441	4.8	16.8	22.7	29.5	19.5	6.8	**0.027**
Occupation (%)								
Professional or manager	63	2.5	14.3	26.1	27.7	20.6	8.8	
Non-manual	398	4.3	16.8	22.1	29.	20.1	6.8	
Manual	71	4.1	18.9	27.0	25.7	18.9	5.4	
Not in work force	288	4.2	16.0	20.8	31.6	18.8	8.7	0.670
Smoking status (%)								
Never	878	2.3	12.4	24.7	30.1	21.1	9.5	
Former	295	3.1	18.0	21.4	30.9	18.3	8.5	
Current	241	8.7	23.2	21.6	23.2	19.9	3.3	**<0.001**
Leisure time physical activity (%)								
≤1hour/week	586	4.3	17.9	24.6	27.5	17.6	8.2	
1.1-3.0 hour/week	388	3.9	11.9	26.3	26.6	21.9	9.5	
3.1-5.0 hour/week	237	3.0	16.0	21.1	31.7	20.3	8.0	
>5 hour/week	211	0.5	13.3	21.3	36.0	22.3	6.6	**0.043**
Television viewing (%)								
<8 hour/week	508	3.5	14.6	21.5	28.7	22.8	8.9	

8-14 hour/week	474	3.4	13.7	23.6	32.1	19.0	8.2	
15-21 hour/week	259	1.5	15.8	30.1	26.6	17.4	8.5	
>21 hour/week	165	4.8	21.8	21.8	27.3	18.8	5.5	0.099
Parity (%)								
0	119	5.0	19.3	21.9	33.6	14.3	5.9	
1	185	3.8	15.7	23.2	29.2	20.0	8.1	
2	259	1.9	13.1	22.8	31.3	20.9	10.0	
3+	109	6.4	15.6	21.1	22.0	23.9	11.0	0.429

Eating frequency and the number of dietary guidelines achieved

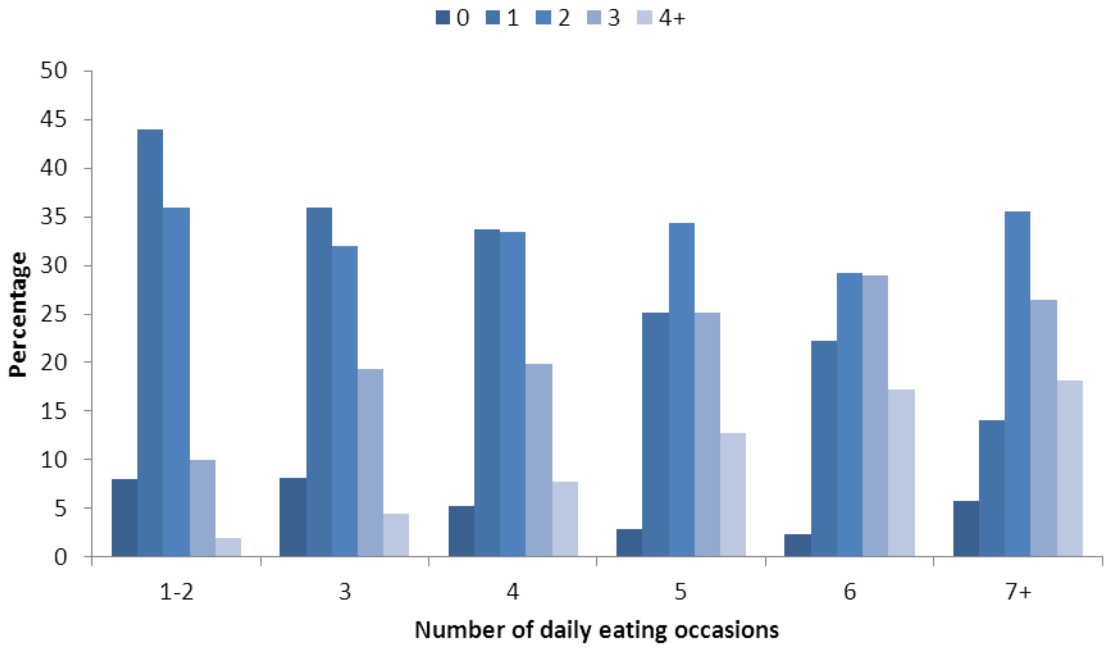
The percentage of men and women achieving each number of dietary guidelines by number of daily eating occasions are shown in Figure 7.A.1a and Figure 7.A.1b. Chi-square analyses were used to test for differences in the number of dietary guidelines achieved by eating frequency group. The results were P<0.001 for men and women. As eating frequency increased, the proportion of men and women achieving at least four of the dietary guidelines tended to increase and the percentage who were achieving only one or two guidelines decreased.

Figure 7.A.1a. Percentage of men achieving each number of dietary guidelines by number of daily eating occasions



The number of men in each eating frequency group was: 1-2 times/day n=75, 3/day n=295, 4/day n=339, 5/day n=269, 6/day n=166, 7+/day n=85.
See Section 2.4.3 for the dietary recommendations for Australian adults.

Figure 7.A.1b. Percentage of women achieving each number of dietary guidelines by number of daily eating occasions



The number of women in each eating frequency group was: 1-2 times/day n=50, 3/day n=222, 4/day n=338, 5/day n=419, 6/day n=291, 7+/day n=121.
See Section 2.4.3 for the dietary recommendations for Australian adults.

Eating frequency and being on a weight loss diet

To examine whether being on a weight loss diet was associated with eating frequency, Fishers exact test was used and the results are presented in Table 7.A.2. Pregnant women were excluded from the analysis. Being on a weight loss diet was not associated with meal frequency for men or for women.

Table 7.A.2. Number of eating occasions for men and women stratified by whether or not participants were currently on a weight loss diet

	Men				Women			
Number of eating occasions	Not on weight loss diet N=1233		On weight loss diet N=35		Not on weight loss diet N=1363		On weight loss diet N=127	
	n	%	n	%	n	%	n	%
1-2	75	6.1	4	11.4	49	3.6	3	2.4
3	299	24.3	8	22.9	205	15.0	22	17.3
4	333	27.0	13	37.1	331	24.3	24	18.9
5	274	22.2	6	17.1	393	28.8	40	31.5
6	166	13.5	3	8.6	273	20.0	27	21.3
7+	86	7.0	1	2.9	112	8.2	11	8.7

Chi-square values: men P=0.498; women P=0.753.

In Chapter 7, the effect of one additional eating occasion on cardio-metabolic risk factors was estimated after adjusting for SES and physical activity (Table 7.5a and Table 7.5b). Subjective (LTPA estimated from a questionnaire) and objective (steps per day estimated from pedometers) measures of physical activity are compared in Table 7.A.3. The strength and significance of the associations was similar for the two models.

Table 7.A.3. Coefficents from regression of cardio-metabolic risk factors on number of eating occasions, comparison of models adjusting for LTPA and steps per day

	LTPA[a]		Steps[b]	
Cardio-metabolic risk factor	β	95% CI	β	95% CI
Men				
Waist circumference (cm)	**-0.89**	**-1.30, -0.48**	**-0.84**	**-1.25, -0.43**
BMI (kg/m^2)	**-0.34**	**-0.50, -0.18**	**-0.32**	**-0.49, -0.16**
Fasting glucose (mmol/L)	-0.01	-0.03, 0.01	-0.01	-0.03, 0.01
Fasting insulin (mU/L)	**-0.34**	**-0.51, -0.17**	**-0.31**	**-0.47, -0.14**
HOMA	**-0.08**	**-0.12, -0.04**	**-0.07**	**-0.11, -0.03**
Triglycerides (mmol/L)	**-0.03**	**-0.06, -0.01**	**-0.03**	**-0.06, -0.01**
Total cholesterol (mmol/L)	**-0.08**	**-0.12, -0.03**	**-0.08**	**-0.12, -0.03**
LDL cholesterol (mmol/L)	**-0.06**	**-0.10, -0.02**	**-0.06**	**-0.10, -0.02**
HDL cholesterol (mmol/L)	0.003	-0.01, 0.01	0.002	-0.01, 0.01
Systolic blood pressure (mmHg)	0.29	-0.21, 0.79	0.27	-0.24, 0.77
Diastolic blood pressure (mmHg)	-0.37	-0.77, 0.03	-0.36	-0.76, 0.04
Metabolic syndrome score	**-0.05**	**-0.08, -0.02**	**-0.05**	**-0.08, -0.02**
Women				
Waist circumference (cm)	-0.17	-0.59, 0.25	-0.09	-0.51, 0.32
BMI (kg/m^2)	-0.12	-0.30, 0.07	-0.10	-0.28, 0.09
Fasting glucose (mmol/L)	**-0.02**	**-0.04, -0.004**	**-0.02**	**-0.04, -0.004**
Fasting insulin (mU/L)	-0.11	-0.26, 0.04	-0.09	-0.24, 0.05
HOMA	-0.03	-0.06, 0.002	-0.03	-0.06, 0.01
Triglycerides (mmol/L)	-0.01	-0.03, 0.01	-0.01	-0.03, 0.01
Total cholesterol (mmol/L)	-0.03	-0.07, 0.01	-0.03	-0.07, 0.01
LDL cholesterol (mmol/L)	-0.02	-0.06, 0.01	-0.02	-0.06, 0.01
HDL cholesterol (mmol/L)	-0.0003	-0.02, 0.01	-0.003	-0.02, 0.01
Systolic blood pressure (mmHg)	-0.08	-0.038, 0.54	0.10	-0.37, 0.56
Diastolic blood pressure (mmHg)	-0.01	-0.41, 0.39	0.01	-0.39, 0.41
Metabolic syndrome score	-0.03	-0.07, 0.002	-0.03	-0.06, 0.01

[a]Analyses for men adjusted for age, education and LTPA; analyses for women adjusted for age, education, LTPA and alcohol intake.
[b]Analyses for men adjusted for age, education and steps; analyses for women adjusted for age, education, steps and alcohol intake.

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Smith KJ, Gall SL, McNaughton SA, Blizzard L, Dwyer T, Venn AJ. Skipping breakfast: longitudinal associations with cardiometabolic risk factors in the Childhood Determinants of Adult Health Study. American Journal of Clinical Nutrition. 2010; 92(6): 1316-5.

Chapter 9. Summary, future directions and conclusions

9.1 Background and aims of the thesis

In Australia, CVD is the leading cause of death (1) and diabetes is the fastest growing chronic disease (2). Dietary factors have been shown to be associated with the risk of developing CVD and type 2 diabetes (3). Most studies examining cardio-metabolic risk factors focus on middle and older aged adults. Although this is the time when most cardio-metabolic events occur, early signs of atherosclerosis and insulin resistence have been shown to start early (4-7). Intervening in young adulthood before CVD and type 2 diabetes are established may prevent or delay the onset of these diseases. While some aspects of dietary intake such as high intakes of saturated or trans fat and low intakes of fruit and vegetables have been shown to be associated with cardio-metabolic risk factors, the role of eating behaviours has not been thoroughly examined. A better understanding of eating behaviours may provide useful insights into strategies for improving diet quality and preventing CVD and diabetes. Very little is known about the dietary intake of young Australian adults. In 2004-2006, the CDAH study collected data on eating behaviours, diet quality and cardio-metabolic risk factors in young Australian adults.

The specific aims of the research presented in this thesis were:

1. To describe the eating behaviours (involvement in meal preparation, takeaway food consumption, eating frequency and breakfast skipping) of young Australian adults and the demographic, socio-economic and lifestyle factors associated with them.
2. To determine whether eating behaviours of young Australian adults are associated with diet quality.
3. To determine whether eating behaviours are associated with CVD and type 2 diabetes risk factors in young Australian adults.

This chapter will provide a summary of the findings of the research presented in this thesis, limitations of the study, discussion of the public health implications and future research directions.

9.2 Summary of results

The research presented in this thesis makes an important contribution to increasing the understanding of eating behaviours in young Australian adults and the socio-demographic and lifestyle factors associated with them. Participants who were single and less educated tended to be higher consumers of takeaway food, ate fewer times per day and were more likely to skip breakfast.

Poorer eating behaviours, frequent consumption of takeaway food and skipping breakfast, tended to be associated with other unhealthy behaviours such as smoking, being less physically active and spending more time watching TV. Frequent takeaway food consumption, having a low number of daily eating occasions and skipping breakfast were also associated with poorer diet quality.

Associations between level of involvement in meal preparation and diet quality and obesity have not previously been well examined. The research presented in this thesis was the first to examine associations between involvement in meal preparation and obesity using an objective measure of obesity and the first to examine associations with abdominal obesity. Involvement in meal preparation and purchasing the groceries was not strongly associated with diet quality or weight status.

This research examined associations between eating behaviours and waist circumference, in addition to BMI, as abdominal obesity is more metabolically harmful than overall obesity. The majority of previous studies have only used BMI as a measure of obesity. Participants who ate takeaway food at least twice per week, had a low number of daily eating occasions (men only), and skipped breakfast both as a child and as an adult had a larger waist circumference compared to those who did not have these eating behaviours.

After adjusting for SES and lifestyle factors, eating behaviours were also associated with cardio-metabolic risk factors. For women, frequent takeaway food consumption was associated with higher fasting glucose (0.06mmol/L), higher fasting insulin (0.50mU/L) and a higher HOMA score (13 units) compared to eating takeaway food no more than once per week. Associations between takeaway or fast food consumption and cardio-metabolic risk factors other than obesity, have previously only been examined in the CARDIA study in the USA. The research presented in the eating frequency chapter strengthens the current evidence that a higher eating frequency is associated with lower prevalence of overweight and obesity. It is one of the few observational studies to examine associations between eating frequency and cardio-metabolic risk factors. For men, a higher eating frequency was associated with reduced cardio-metabolic risk. With an additional eating occasion there was a reduction in mean values for waist circumference (0.77cm), fasting glucose (0.02mmol/L), insulin (0.32mU/L), triglycerides (0.03mmol/L), total cholesterol (0.07mmol/L) and LDL cholesterol (0.05mmol/L). The research presented in the breakfast skipping chapter provides further evidence that skipping breakfast is associated with poor diet quality and overweight and obesity. This was the first study in the world to examine the long term effects skipping breakfast has on cardio-metabolic risk factors. Participants who skipped breakfast in both childhood and adulthood had a larger waist circumference (4.63cm), and higher fasting insulin (2.02mU/L) total cholesterol (0.40mmol/L) and LDL cholesterol (0.40mmol/L) than those who ate breakfast at both time points.

9.3 Limitations

There are a number of limitations that need to be considered when interpreting the findings in this thesis such as measurement error, selection bias and confounding. Dietary intake was assessed using a FFQ that required participants to estimate, on average, how many times they had eaten each item over the previous 12 months. Some people may have had difficulty averaging their usual intake into the number of times consumed per day, week or month. As a result, the frequency participants recalled may be strongly influenced by recent diet and therefore their responses in the FFQ may reflect diet over recent weeks or months rather than the previous 12 months (8). In addition, the FFQ did not include options for serving sizes and it was assumed one serve was consumed each time. Therefore a measure of energy intake was not available. This is a limitation, particularly since obesity was one of the outcomes of interest for this thesis. However, the major variance of food intake is explained by frequency alone (9) and the addition of serving sizes can introduce more error as participants are required to estimate not only how often they consume each item but also how much, on average, they consume. This amount is then multiplied by an average amount of energy from a variety of similar products. Although having a measure of energy intake would be beneficial to examine if eating behaviours were associated with higher energy intakes, estimates of energy intake also have limitations. All analyses in this thesis were adjusted for age and physical activity and stratified by (or adjusted for) sex, which are key determinants of energy intake (10) and may partially overcome the limitation of not having a measure of energy intake. Another limitation is the possibility of social desirability bias, this would occur if some participants reported what they thought were socially acceptable responses. However, if this did occur in our sample, participants would be more likely to under-report their takeaway food consumption and breakfast skipping. Therefore, it is likely that the true estimates of the associations with these outcomes would have been underestimated.

Another limitation is that the meal pattern chart only assessed meal patterns for the previous day and it is not known if that day was representative of their normal eating patterns. There is little research on the optimal way to collect information on meal patterns and the number of days required to reliably assess habitual patterns. The method used in the CDAH study was relatively simple and designed specifically to measure meal patterns whereas other methods of dietary assessment focus on food and nutrient intake. Other methods capable of assessing meal patterns (diet records, diet recalls and diet history) are time consuming and labour intensive and therefore not practical for large epidemiological studies.

Although the ASHFS was a nationally representative sample of Australian school children not all of the participants took part in the follow-up study and as a result the CDAH sample was not a representative sample of young Australian adults. Those who did not participate in the follow-up study tended to be from a lower SES area and were more likely to be overweight and to think a healthy diet was of little or no importance in childhood. Compared to the general Australian population of 25-34 year olds the CDAH study included a greater proportion of participants with a high SES (employed as professionals or managers). Sample selection (or missing data) can result in selection bias in an analytical study if the association between the outcome and its covariates differs between those included in the study and those not included. However, if the analyses are adjusted for the factors that vary between participants and non-participants, this potential source of bias can be removed. Therefore, what is important in an analytical study is that there is data available on the relevant factors and that they are adjusted for in the analyses. Miettenen referred to this as having a wide distribution of confounders and effect modifiers (11). The CDAH study has measurements on an extensive range of possible confounders and effect modifiers, and those that were found to be important were included in the analyses. Provided participants and non-participants do not differ by factors that were not measured or which were measured with error, the results presented in this thesis should be robust. An example of an unmeasured potential confounder is that breakfast skipping may be associated with other unhealthy lifestyle behaviours such as sleep duration. Both short and long sleep duration have been reported to be associated with cardio-metabolic risk (12). Breakfast skippers may go to bed later than breakfast consumers and therefore have shorter sleep duration, or they may prefer to sleep later instead of getting up to have breakfast and therefore have a longer sleep duration than breakfast consumers.

Another limitation is that the majority of the analyses in this thesis were cross-sectional and therefore the direction of the associations is not certain. In addition, the questions used to assess eating behaviours asked about current behaviours, whereas obesity and cardio-metabolic risk factors develop over time. However, the findings generally support previous longitudinal studies, when longitudinal studies have been conducted. Further follow-up of the CDAH sample will allow the direction of the association to be determined and provide further insights into the effect eating behaviours have on cardio-metabolic risk.

9.4 Public health implications

The research presented in this thesis has focused on a range of eating behaviours that could be targeted to improve dietary intake in the population and prevent CVD and type 2 diabetes. The results of this work have implications in relation to national dietary recommendations to limit takeaway food to once a week and to regularly eat breakfast. This research has also identified that among young Australian adults, those who are single or of low SES are important target groups for nutrition promotion. In addition, the findings highlight certain eating behaviours and target groups for which food and nutrition policy changes (for example food and menu labelling and taxation of unhealthy foods) may be particularly relevant.

9.4.1 Socio-economic status and diet quality

Previous research shows that socio-economically disadvantaged groups have higher rates of overweight, obesity and chronic disease (13) and dietary intakes that are less consistent with dietary recommendations, for example higher intakes of total and saturated fat, and lower intakes of fruit, vegetables and micronutrients (14-16). In this sample of young Australian adults, some but not all eating behaviours were associated with SES as measured by education and employment. Takeaway food consumption was not associated with education or employment for men. For women those who were in the workforce were higher consumers of takeaway food than those who were not employed, possibly reflecting affordability and time pressures. The takeaway food question used in the CDAH study only asked about frequency of takeaway food and not about the types of foods consumed. Whether there were SES differences in the “healthy” and “less healthy” takeaway foods consumed was not able to be examined. In a previous national study of Australian adults aged 18-65 years, individuals from the higher SES groups were more likely to consume takeaway food. However, when the types of foods consumed were compared, those who were the most socio-economically disadvantaged were less likely to chose foods aligned with the dietary guidelines (17). A higher consumption of “less healthy” takeaway food items may be contributing to the higher intakes of energy, fat and saturated fat that are observed in socio-economically disadvantaged groups (17).

It has been suggested that the availability of healthy and less healthy foods may differ by the socio-economic level of the area. A review of 54 studies in the US found that fast food restaurants and the availability of energy dense foods was higher in low income areas and access to supermarkets and healthy foods was lower (18). This study was supported by a systematic review of fast food access studies that reported fast food restaurants were more prevalent in low income areas (16/21 studies) than moderate to high income areas. However, Australian studies from Brisbane and Victoria suggest individual and household characteristics determine the purchasing of fast foods, not area-level socio-economic characteristics (19, 20).

In addition to associations between SES and takeaway food consumption, the results reported in this thesis also showed that men and women who were not university educated were more likely to only eat 1-2 times per day and occupation was not associated with eating frequency. Low SES was associated with skipping breakfast. Participants who had a lower level of education or who were employed in manual occupations were more likely to skip breakfast. Common breakfast foods come from the core food groups and therefore skipping breakfast may be contributing to the socio-economic inequalities in dietary intake.

Public health messages targeting individuals of low SES that promote limiting takeaway food consumption, choosing healthier takeaway food options and consuming breakfast may help improve diet quality in this group.

9.4.2 Takeaway and fast food consumption

The results reported in the takeaway food chapters provide evidence to support the National Heart Foundation of Australia's recommendation to try to limit takeaway food to no more than once a week (21). Young adults have been reported to have the highest intake of takeaway food consumption in the USA (22, 23) and the results from this thesis suggest that initiatives to reduce takeaway food consumption and to provide healthier takeaway food options may improve diet quality and help prevent obesity. The amount of energy consumed per eating occasion tends to be higher from foods purchased away from home than food prepared at home (23). Fast food items in Australia are generally unhealthy with very few products being classified as low in total fat, saturated fat or sodium (24). Salad and sandwich items, which are often perceived to be healthy choices, can be as high in saturated fat, sugar and sodium as traditional items such as pizza or burgers (24). There is a wide variation in the nutritional value for similar products across companies and this suggests that companies could make changes to a large number of items to improve their nutritional value (24).

In 2006, the National Heart Foundation of Australia introduced the "Tick" to meals eaten away from the home. The Tick provides access to healthier meals by improving the food supply and changing public perception of what constitutes a takeaway meal (25). All Tick meals are independently tested to ensure they meet standards for portion size, saturated and trans fat, salt and vegetable or fibre content. Outlets must provide the nutrition information panel for Tick approved meals at point of sale so customers know exactly what they are eating. The majority of people who had tried a Tick meal said they intended to buy them again (25), which suggests healthier options can be popular choices. The Heart Foundation is the first health organisation in the world to provide independent approval in the "eating out" industry. At the end of 2010, Tick meals were available from McDonalds, Qantas, Crust Pizza, Pizzacutters and two sports stadiums (26). The number of businesses that have received the Tick over the last four years is small and this may be because foods or meals often need to be modified to meet the nutrition recommendations which can be a time consuming and expensive process. In addition, businesses are also required to pay an annual licensing fee to the National Heart Foundation to cover costs associated with running the Tick program.

In the United States, 41 senior menu developers and marketing executives from major restaurant chains were interviewed to determine barriers to adding healthy food items to the menu (27). The barriers identified included low sales of healthy items, high labour costs, short shelf life of fruits and vegetables and an inconsistent supply of fresh ingredients. There was also a belief that customers want to indulge when eating out and there was a reluctance to call foods "healthy" in case it scared customers away. Some businesses reported offering healthy options to avoid the "veto vote", where one person in the group who values healthy options influences the entire group to go somewhere else if healthy items are not available (27). While some companies offer healthier menu options, there is little information available on the sales of these products compared to traditional menu items. This makes it difficult to determine how these items will impact on population health.

In addition to voluntary changes by the food industry to provide healthier options, another strategy to improve the dietary intake of takeaway food consumers is by the introduction of regulatory policy that mandates improvements in the nutritional quality of the food. In New York City, the Board of Health introduced a regulation to ban the use of artificial trans fat in all licensed food establishments. Over the 18 month phasing out period, the estimated use of artificial trans fats decreased from approximately 50% of restaurants to less than 2% (28). Businesses were encouraged to replace trans fat with unsaturated fats and for some foods this resulted in a healthier fatty acid profile. For example, the saturated fat content of French fries from leading fast food chains was reduced on average by 11% and the total trans and saturated fat content was reduced by 54%. Before it became mandatory, this regulation was originally introduced as a voluntary campaign but very few companies made changes to their cooking methods. By removing artificial trans fat from meals purchased away from home, consumers were eating products that were better for their health, without having to know about the harmful effects of trans fat or having to make the decision to choose a healthier product.

9.4.3 Eating frequency

The results reported in this thesis showed increased eating frequency was associated with better diet quality. This suggests those who ate more often were not just filling up on "empty" foods but were choosing foods that are part of a healthy diet. A higher number of eating occasions was also associated with lower cardio-metabolic risk factors for men. However, individuals should not be recommended to increase the number of eating occasions until further studies investigate the effect of increased eating frequency on satiety and how this impacts on energy intake. Although some trials have reported a higher eating frequency is associated with increased satiety, the benefits have been small and the number of meals consumed is often unrealistic for everyday living (29, 30). While it is possible a greater eating frequency may result in a lower energy intake, it is also possible individuals may not reduce the energy intake at each meal enough (through reductions in either portion size or energy density of foods) to compensate for the increased frequency, which could lead to weight gain and an increased risk of obesity. In addition, an increase in eating frequency could result in increased consumption of energy-dense foods which may also result in weight gain. Trials examining the effect of snacking on energy intake have shown mixed results. A recent study reported the energy content of a pre-meal snack was not compensated for at the following meal and resulted in positive energy balance (31). In contrast, a trial examining the long term effects of snacking on energy compensation and body weight found there was no change in body weight after six months (32). This suggests that over time, individuals may adapt to an increased eating frequency.

9.4.4 Breakfast skipping

Breakfast skipping is a modifiable behaviour that has been shown to have negative effects on health. However, breakfast skipping is common and 14% of the ASHFS children and 28% of the CDAH sample were classified as breakfast skippers. The research presented in this thesis regarding breakfast skipping provides further support that breakfast is a very important meal. Participants who skipped breakfast as a child, and 20 years later, as an adult had higher cardio-metabolic risk factors. This adds to the previous literature showing breakfast consumption is beneficial for weight loss and weight maintenance in adults and children (33, 34), and may help to dispel myths that skipping meals is a useful strategy for weight loss (35, 36). Establishing regular breakfast habits in children may improve long term health as regular breakfast consumption in adolescents has been shown to predict breakfast consumption in young adults (37). Skipping breakfast may also have a negative effect on school performance that results in lower education achievement. A recent systematic review of 45 controlled trials found breakfast consumption generally had a positive effect on memory and attention compared with skipping breakfast (38). The benefits were strongest when testing occurred later in the morning.

To try and reduce the number of children who go without breakfast, Government and non-Government organisations are investing money and resources into school breakfast programs. For example, the Red Cross runs Good Start Breakfast Clubs that provide healthy breakfasts to children in every state and territory in Australia. There are over 260 Good Start Breakfast Clubs nationally that provide over 800,000 meals each year (39). In 2010, the Tasmanian State Government committed $400,000 over four years to run school breakfast programs. In addition to improving future cardio-metabolic health, these programs may also help increase school attendance and reduce absenteeism. Despite the popularity of these programs, very little is known about their effectiveness. Two randomised controlled trials in the USA and the UK have shown that having school breakfasts available to all students free of charge is not effective at increasing breakfast consumption (40, 41). Other strategies to increase breakfast consumption that have a greater family and community focus may be needed.

The analyses used in this thesis only examined whether or not breakfast was eaten and the types of foods consumed for breakfast were not able to be determined. It is possible that metabolically, eating anything is better than skipping breakfast, and the importance of breakfast is in breaking the overnight fast. However, breakfast is often a nutritious meal as common breakfast foods come from the core food groups, therefore when promoting the benefits of breakfast it would be appropriate to also promote consuming a healthy breakfast such as whole grain breads and cereals, fruit and low fat dairy. In addition, preparation of a healthy breakfast requires little or no cooking skills. Several studies have reported ready to eat cereals are associated with better nutrient intakes, lower BMI and more favourable lipid profiles (boys only) compared to breakfasts that do not include ready to eat cereals (42-44). However, it is important that studies are conducted by researchers that are not funded by the cereal industry because there is evidence industry funded research tends to report findings favourable to that industry (45). High fibre foods, including some ready to eat breakfast cereals, are associated with lower risk of obesity, improved blood glucose control and higher satiety. Although ready to eat breakfast cereals are often fortified with vitamins and minerals that improve their nutritional value they can also be high in added sugar and salt.

9.4.5 Policy – food labelling and taxation

Public health messages that promote the benefits of eating a healthy breakfast and limiting the consumption of takeaway food to once a week may help reduce cardio-metabolic risk factors in young adults. However, to make larger nationwide improvements, changes to policy may be more effective. Examples of public health nutrition policy that are relevant in this context and will be discussed are food labelling and taxation.

Introducing labelling on the front of food packaging and menus would help to support individuals to make healthier food choices (46). The independent Review of Food Labelling Law and Policy recently recommended a multiple traffic light approach be used on the front of the pack (47). The traffic light system allows consumers to make instant decisions on the healthiness of food and drink products without the need for extensive nutrition knowledge. Coloured circles are presented for key nutrients: green signifies a healthy choice; orange is an ok choice; red is a less healthy or an unhealthy choice (47). The traffic light system has been shown to be the most effective at helping Australian adults identify healthy products when compared to three other labelling systems (48). The review also recommended chain food service outlets present the energy content for standardised food items on menu boards and have additional nutritional information readily accessible (47). These changes would help consumers make informed choices about what they are purchasing and may also encourage industry to make changes to improve the nutritional quality of their products to avoid being labelled with a red traffic light. While calorie labelling may help raise awareness of the high energy content of takeaway food items, recent studies have reported it may not have a large impact on changing items purchased (49, 50). Reducing portion sizes and changing the combination meals to include lower calorie options are other strategies that could significantly reduce the average energy content of purchases (49).

Using fiscal policies, such as taxation or pricing incentives, to promote production of healthier foods and to also increase access to and consumption of these items is another way to potentially improve dietary intake (46). Taxation of unhealthy foods has been reported to have the potential to make a large impact on the health of the Australian population (51). In contrast, programs that target individuals to increase fruit and vegetable consumption or diet and exercise interventions to reduce overweight and obesity have been found to be either not cost-effective or to have only a small impact on population health (51).

9.5 Future directions

- As mentioned above, longitudinal studies are needed to confirm the findings from the cross-sectional analyses reported in this thesis. Future follow-up of the CDAH sample will allow this but the findings should also be confirmed in other study populations. Research examining whether eating behaviours are associated with CVD events is also needed.
- Long term studies with more than two follow-up periods are needed to confirm the findings that skipping breakfast for a long period of time has detrimental effects on cardio-metabolic risk factors. However, unless current cohort studies already have this data it will be a long time before these findings can be confirmed. Evaluation of school breakfast programs in Australia is also needed to determine if Government funded programs are actually reaching the children that need breakfast and converting breakfast skippers into breakfast eaters.
- In addition to observational studies, interventions that recommend eating breakfast and limiting takeaway to no more than once per week would be a useful way to evaluate the effect these eating behaviours have on body weight and cardio-metabolic risk factors over time.
- More studies are needed to examine the effect of eating frequency on appetite and energy intake. There is also a need for researchers to determine the most appropriate method of measuring meal patterns and eating frequency for epidemiological studies.
- More research is needed on how to improve the availability and increase consumption of healthier options at takeaway and fast food outlets and whether consuming these items is associated with improved weight status and cardio-metabolic health.
- Interventions that change the “obesogenic” environment and target populations rather than individuals are needed. These interventions could include reducing the portion sizes of standard takeaway and fast food items to reduce the energy content per serve. Another option could be changing policy to reduce the price of healthy items such as fruit and vegetables.

9.6 Conclusions

The findings from this thesis show takeaway food consumption, eating frequency and skipping breakfast are associated with cardio-metabolic risk factors in young Australian adults. These findings suggest public health messages that promote limiting takeaway food consumption to no more than once per week and highlight the importance of not skipping breakfast may help reduce the risk of CVD and type 2 diabetes. The findings of this thesis also suggest that among young Australian adults, single adults and those of low SES may be at particular risk and are important target groups for strategies to promote healthier eating behaviours.

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Appendix 9.A Dietary questionnaire used in the Childhood Determinants of Adult Health (CDAH) study

0891594635

NAME: ______________________________

ID NUMBER: _______________

CDAH
CHILDHOOD
DETERMINANTS
of ADULT HEALTH

QUESTIONNAIRE 3: DIETARY QUESTIONNAIRE

SEE OVERLEAF FOR DETAILED INSTRUCTIONS

Shade Circles Like This

Not Like This or

Cross Out Mistakes Like This

Or by writing clearly using the boxes where provided.
Please use BLOCK LETTERS where required

Cross out any mistakes & write correct answer just below the relevant boxes

Please use a black or blue pen if possible

Check that both sides of each page are completed.

Please note: This front sheet, containing your name, will be removed from the questionnaire and destroyed before data is entered and stored.

9352594636

OFFICE USE ONLY

(Clinic staff attach bar code here)

2

HOW TO COMPLETE THIS SECTION:
For each food item listed, circle the box that best represents your average pattern of consumption of that food over the previous 12 months.

For example:
If you usually eat baked beans for breakfast every day, fill in *"Once per day"* (see example below). If, however, you never eat baked beans, fill in "*Never, or less than once a month*"

FOOD PRODUCT LIST	Average number of times consumed in the last 12 months								
	Never or less than once a month	1-3 times per month	Once per week	2 - 4 times per week	5 - 6 times per week	Once per day	2 - 3 times per day	4 - 5 times per day	6+ times per day
Baked beans	○	○	○	○	○	●	○	○	○

Mixed foods
Some commonly consumed mixed foods, such as salads, stir-fried vegetables etc have been included as distinct items. Other foods such as sandwiches are not listed as distinct items as their composition varies depending on how they are made up. For these foods think about the separate ingredients and answer accordingly.

For example:
- If you usually eat a ham and mixed salad sandwich once a week and you usually eat no other ham or mixed salad during the week, fill in the "*once per week*" box for **ham** and the *"once per week"* box for **green/mixed salad**. Don't forget to include the bread/roll in your breads total either!

Seasonal foods
There are some foods that you eat only when they are in season. For very seasonal fruits such as stone fruits, melons etc you should estimate your average consumption when the fruits are in season.

For example:
- If you eat fresh plums once a week during summer, and eat no plums for the rest of the year you should fill in the box for *"once per week"*
- If you eat fresh plums once a week during summer, and eat canned plums once a week for the rest of the year you should also fill in the box for *"once per week"*

Important points to remember
- - Please fill in one response for every food listed.
  - If you never eat a particular food, fill in the "*Never, or less than once a month*" box.
- - Think about how often you eat take away or restaurant prepared foods.
- - If you make a mistake, put a cross **X** through the wrong answer, and fill in the correct answer

OFFICE USE ONLY

SCAN	VERIFY	CHECK

6141594639

3

SECTION A : This section of the questionnaire is designed to estimate your usual pattern of food intake by providing us with information on your average consumption of certain foods and beverages during the last 12 months

<u>BEFORE STARTING THIS QUESTIONNAIRE, PLEASE MAKE SURE THAT YOU HAVE READ THE INSTRUCTIONS ON THE PRECEEDING PAGES</u>

For each food item listed, indicate how often **<u>on average</u>** you consumed that food in the **<u>past 12 months</u>**. Please fill in one circle for each food listed, even if you **never** eat it.

FOOD PRODUCT LIST	Average number of times consumed in the last 12 months								
	Never or less than once a month	1-3 times per month	Once per week	2 - 4 times per week	5 - 6 times per week	Once per day	2 - 3 times per day	4 - 5 times per day	6+ times per day
1. DAIRY FOODS									
Flavoured milk drink (e.g milkshake, iced coffee, hot chocolate)	O	O	O	O	O	O	O	O	O
Milk as a drink	O	O	O	O	O	O	O	O	O
Milk in hot beverages (e.g. in coffee, tea)	O	O	O	O	O	O	O	O	O
Milk added to breakfast cereal	O	O	O	O	O	O	O	O	O
Cream or Sour Cream	O	O	O	O	O	O	O	O	O
Ice-cream	O	O	O	O	O	O	O	O	O
Yoghurt, plain or flavoured (including fromage frais)	O	O	O	O	O	O	O	O	O
Cottage or ricotta cheese	O	O	O	O	O	O	O	O	O
Cream cheese (e.g. Philadelphia™)	O	O	O	O	O	O	O	O	O
Cheddar and other cheeses	O	O	O	O	O	O	O	O	O
2. BREAD & CEREAL FOODS									
White bread,toast or rolls	O	O	O	O	O	O	O	O	O
Wholemeal/mixed grain bread, toast or rolls	O	O	O	O	O	O	O	O	O
English muffin, bagel or crumpet	O	O	O	O	O	O	O	O	O
Flat bread (e.g. pita,chapatti)	O	O	O	O	O	O	O	O	O
Dry or savoury biscuits, crispbread, crackers	O	O	O	O	O	O	O	O	O
Muesli	O	O	O	O	O	O	O	O	O
Cooked porridge	O	O	O	O	O	O	O	O	O
Breakfast cereal	O	O	O	O	O	O	O	O	O
Rice (white or brown)	O	O	O	O	O	O	O	O	O
Pasta (including filled), noodles	O	O	O	O	O	O	O	O	O

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4

FOOD PRODUCT LIST	Average number of times consumed in the last 12 months								
	Never or less than once a month	1-3 times per month	Once per week	2 - 4 times per week	5 - 6 times per week	Once per day	2 - 3 times per day	4 - 5 times per day	6+ times per day
3. MEAT,FISH,EGGS									
Mince dishes (e.g. rissoles, meatloaf)	O	O	O	O	O	O	O	O	O
Mixed dishes with beef, veal, lamb, pork (e.g. casserole,stir fry)	O	O	O	O	O	O	O	O	O
Beef, veal- roast,chop or steak	O	O	O	O	O	O	O	O	O
Lamb-roast,chop	O	O	O	O	O	O	O	O	O
Pork-roast,chop	O	O	O	O	O	O	O	O	O
Ham/bacon	O	O	O	O	O	O	O	O	O
Luncheon meats,salami	O	O	O	O	O	O	O	O	O
Sausages (beef,pork,other)	O	O	O	O	O	O	O	O	O
Liver (including pate)	O	O	O	O	O	O	O	O	O
Other offal (e.g. kidneys)	O	O	O	O	O	O	O	O	O
Mixed dishes with chicken, duck, turkey (e.g. casserole,stir-fry)	O	O	O	O	O	O	O	O	O
Chicken,turkey,duck- roast,steamed or barbequed	O	O	O	O	O	O	O	O	O
Canned fish (e.g. tuna, salmon, sardines)	O	O	O	O	O	O	O	O	O
Fresh fish- steamed,baked,grilled	O	O	O	O	O	O	O	O	O
Frozen fish- steamed,baked,grilled	O	O	O	O	O	O	O	O	O
Fish,fried	O	O	O	O	O	O	O	O	O
Mussels/oysters	O	O	O	O	O	O	O	O	O
Lobster/crayfish/yabbies	O	O	O	O	O	O	O	O	O
Calamari/squid	O	O	O	O	O	O	O	O	O
Prawns	O	O	O	O	O	O	O	O	O
Other seafood	O	O	O	O	O	O	O	O	O
Egg	O	O	O	O	O	O	O	O	O

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FOOD PRODUCT LIST	Average number of times consumed in the last 12 months								
	Never or less than once a month	1-3 times per month	Once per week	2 - 4 times per week	5 - 6 times per week	Once per day	2 - 3 times per day	4 - 5 times per day	6+ times per day
4. SWEETS, BAKED GOODS AND SNACKS									
Cakes, sweet muffins, scones or pikelets	O	O	O	O	O	O	O	O	O
Sweet pies or sweet pastries	O	O	O	O	O	O	O	O	O
Other pudding or desserts	O	O	O	O	O	O	O	O	O
Plain, sweet biscuits	O	O	O	O	O	O	O	O	O
Cream, chocolate biscuits	O	O	O	O	O	O	O	O	O
Meat pie, sausage roll or other savoury pastries	O	O	O	O	O	O	O	O	O
Pizza	O	O	O	O	O	O	O	O	O
Hamburger	O	O	O	O	O	O	O	O	O
Chocolate (including chocolate bars e.g. Mars bar™)	O	O	O	O	O	O	O	O	O
Other confectionary	O	O	O	O	O	O	O	O	O
Potato chips, corn chips, Twisties™ etc.	O	O	O	O	O	O	O	O	O
Almonds, walnuts, hazelnuts	O	O	O	O	O	O	O	O	O
Cashews	O	O	O	O	O	O	O	O	O
Coconuts	O	O	O	O	O	O	O	O	O
Peanuts	O	O	O	O	O	O	O	O	O
Pistachio	O	O	O	O	O	O	O	O	O
Seeds-pumpkin, sesame, pine nuts, tahini	O	O	O	O	O	O	O	O	O
Other nuts, seeds	O	O	O	O	O	O	O	O	O
5. DRESSINGS AND SPREADS									
Oil and vinegar dressing	O	O	O	O	O	O	O	O	O
Mayonnaise or other creamy dressings	O	O	O	O	O	O	O	O	O
Jam, marmalade, syrup or honey	O	O	O	O	O	O	O	O	O
Peanut butter, other nut spreads	O	O	O	O	O	O	O	O	O
Vegemite™, Marmite™ or Promite™	O	O	O	O	O	O	O	O	O
Creamy dips and spreads	O	O	O	O	O	O	O	O	O

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FOOD PRODUCT LIST	Average number of times consumed in the last 12 months								
	Never or less than once a month	1-3 times per month	Once per week	2 - 4 times per week	5 - 6 times per week	Once per day	2 - 3 times per day	4 - 5 times per day	6+ times per day
6. NON-DAIRY									
Fruit juice (100%)	O	O	O	O	O	O	O	O	O
Vegetable, tomato juices	O	O	O	O	O	O	O	O	O
Fruit juice drink or fruit cordial	O	O	O	O	O	O	O	O	O
Low-joule cordial	O	O	O	O	O	O	O	O	O
Cordial	O	O	O	O	O	O	O	O	O
Low-joule soft drink	O	O	O	O	O	O	O	O	O
Soft drinks (including flavoured mineral water)	O	O	O	O	O	O	O	O	O
Water (including unflavoured mineral water, soda water, tap water)	O	O	O	O	O	O	O	O	O
Coffee-full strength	O	O	O	O	O	O	O	O	O
Decaffeinated coffee	O	O	O	O	O	O	O	O	O
Tea- green or black (ordinary tea)	O	O	O	O	O	O	O	O	O
Herbal tea	O	O	O	O	O	O	O	O	O
Soy beverages	O	O	O	O	O	O	O	O	O
Light beer	O	O	O	O	O	O	O	O	O
Medium strength beer	O	O	O	O	O	O	O	O	O
Full strength beer	O	O	O	O	O	O	O	O	O
Red wine	O	O	O	O	O	O	O	O	O
White wine or champagne/sparkling wine	O	O	O	O	O	O	O	O	O
Wine cooler	O	O	O	O	O	O	O	O	O
Spirit-based mixed drinks (eg Lemon Ruski™)	O	O	O	O	O	O	O	O	O
Sherry/port/ fortified wines	O	O	O	O	O	O	O	O	O
Spirits, liquers	O	O	O	O	O	O	O	O	O
Other alcoholic drinks (e.g cider)	O	O	O	O	O	O	O	O	O

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FOOD PRODUCT LIST	Average number of times consumed in the last 12 months								
	Never or less than once a month	1-3 times per month	Once per week	2 - 4 times per week	5 - 6 times per week	Once per day	2 - 3 times per day	4 - 5 times per day	6+ times per day
7. VEGETABLES (Including frozen and canned)									
Green/mixed salad (including lettuce, tomato etc.) in a sandwich	○	○	○	○	○	○	○	○	○
Green/mixed salad (including lettuce, tomato etc.) as a side-salad with a main meal	○	○	○	○	○	○	○	○	○
Stir-fried or mixed vegetables	○	○	○	○	○	○	○	○	○
Vegetable casserole	○	○	○	○	○	○	○	○	○
Potato- boiled, mashed or baked	○	○	○	○	○	○	○	○	○
Hot chips/roast potatoes/potato wedges	○	○	○	○	○	○	○	○	○
Sweet potato	○	○	○	○	○	○	○	○	○
Pumpkin	○	○	○	○	○	○	○	○	○
Peas (including snow peas)	○	○	○	○	○	○	○	○	○
Green beans	○	○	○	○	○	○	○	○	○
Silverbeet / spinach	○	○	○	○	○	○	○	○	○
Broccoli	○	○	○	○	○	○	○	○	○
Cauliflower	○	○	○	○	○	○	○	○	○
Brussel sprouts, cabbage, coleslaw	○	○	○	○	○	○	○	○	○
Carrots	○	○	○	○	○	○	○	○	○
Mushrooms	○	○	○	○	○	○	○	○	○
Capsicum	○	○	○	○	○	○	○	○	○
Sweetcorn, corn on the cob	○	○	○	○	○	○	○	○	○
Zucchini, eggplant, squash	○	○	○	○	○	○	○	○	○
Cucumber	○	○	○	○	○	○	○	○	○
Tomatoes (except when in mixed salad)	○	○	○	○	○	○	○	○	○

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FOOD PRODUCT LIST	Average number of times consumed in the last 12 months								
	Never or less than once a month	1-3 times per month	Once per week	2 - 4 times per week	5 - 6 times per week	Once per day	2 - 3 times per day	4 - 5 times per day	6+ times per day
7. VEGETABLES (Including frozen and canned) contd.									
Lettuce (except when in a 'mixed salad')	○	○	○	○	○	○	○	○	○
Celery (except when in a 'mixed salad')	○	○	○	○	○	○	○	○	○
Onion or leek	○	○	○	○	○	○	○	○	○
Soy beans, tofu	○	○	○	○	○	○	○	○	○
Baked beans	○	○	○	○	○	○	○	○	○
Other beans, lentils	○	○	○	○	○	○	○	○	○
8. FRUITS (*Remember instructions for seasonal fruits*)									
Fruits - dried, frozen, canned	○	○	○	○	○	○	○	○	○
Fresh fruit salad	○	○	○	○	○	○	○	○	○
Apple or pear	○	○	○	○	○	○	○	○	○
Orange, mandarin, grapefruit	○	○	○	○	○	○	○	○	○
Banana	○	○	○	○	○	○	○	○	○
Peach, nectarine, plum or apricot	○	○	○	○	○	○	○	○	○
Mango or paw paw	○	○	○	○	○	○	○	○	○
Pineapple	○	○	○	○	○	○	○	○	○
Grapes or berries	○	○	○	○	○	○	○	○	○
Melon (watermelon, rockmelon or honeydew melon)	○	○	○	○	○	○	○	○	○
Other fruit not listed	○	○	○	○	○	○	○	○	○

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FOOD PRODUCT LIST	Average number of times consumed in the last 12 months								
	Never or less than once a month	1-3 times per month	Once per week	2 - 4 times per week	5 - 6 times per week	Once per day	2 - 3 times per day	4 - 5 times per day	6+ times per day
9. VITAMIN and MINERAL SUPPLEMENTS									
Multivitamin with iron or other minerals	○	○	○	○	○	○	○	○	○
Multivitamin	○	○	○	○	○	○	○	○	○
Vitamin A	○	○	○	○	○	○	○	○	○
Vitamin B	○	○	○	○	○	○	○	○	○
Vitamin C	○	○	○	○	○	○	○	○	○
Vitamin E	○	○	○	○	○	○	○	○	○
B- carotene	○	○	○	○	○	○	○	○	○
Calcium	○	○	○	○	○	○	○	○	○
Folic acid / folate	○	○	○	○	○	○	○	○	○
Iron	○	○	○	○	○	○	○	○	○
Zinc	○	○	○	○	○	○	○	○	○
Oatbran or wheatbran	○	○	○	○	○	○	○	○	○
Evening primrose oil / fish oil	○	○	○	○	○	○	○	○	○
Herbal remedies e.g Echinacae	○	○	○	○	○	○	○	○	○
Other nutrients	○	○	○	○	○	○	○	○	○

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SECTION B: This section asks about some of your food habits
(please select ONE answer only)

1. What type of milk do you usually consume?

- O Whole milk
- O Low / reduced fat milk
- O Skimmed milk
- O Evaporated or sweetened condensed milk
- O Soy milk
- O Vitamin/calcium enriched milk
- O Other milk
- O None of the above
- O Don't know

2. When you eat the following products, how often do you eat a low/reduced fat variety?

Product	Never/Rarely	Sometimes	Usually	I don't eat this food
Cream	O	O	O	O
Ice-cream	O	O	O	O
Cheddar- type cheeses	O	O	O	O
Oily salad dressing	O	O	O	O
Spreads (e.g. margarine, peanut butter, mayonnaise)	O	O	O	O

3. How often is the meat you eat trimmed of fat either before or after cooking?

- O Never/Rarely
- O Sometimes
- O Usually
- O I don't eat meat

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4. **How many serves of vegetables (excluding potatoes) do you usually eat each day?** ***(one serve= ½ cup cooked vegetables or 1 cup of salad vegetables)***

O 1 serve or less

O 2-3 serves

O 4-5 serves

O 6 or more serves

O I don't eat vegetables

5. **How many serves of fruit do you usually eat each day?** ***(one serve= 1 medium piece of fruit or 1 cup of diced pieces)***

O 1 serve or less

O 2-3 serves

O 4-5 serves

O 6 or more serves

O I don't eat fruit

6. **When cooking, how often do you or the person who cooks your food use the following?**

Product	Never/Rarely	Sometimes	Usually	Don't know
Olive oil	O	O	O	O
Canola or sunflower oil	O	O	O	O
Vegetable oil	O	O	O	O
Nut oil (eg peanut oil)	O	O	O	O
Butter	O	O	O	O
Margarine	O	O	O	O
Omega 3 or phyto sterol margarine	O	O	O	O
Dairy blend	O	O	O	O
Lard or dripping	O	O	O	O
Other oil: ____________ (please specify)	O	O	O	O

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7. Which <u>one</u> of the following best describes your <u>usual</u> way of eating?

O Vegetarian

O Weight reduction diet

O Diabetic diet

O Fat modified diet

O Other (eg vegan, salt free)

O No special way of eating

8. How many slices of bread do you normally eat in <u>one</u> day? Count a large bread roll as equal to 2 slices and a small bread roll as equal to 1 slice. *(Write 0 if you do not eat bread or rolls.)*

Slices

9. What type of spread do you <u>usually</u> use on bread, savoury biscuits etc?

O I do not use any spread

O Butter

O Poly unsaturated margarine

O Canola

O Table margarine

O Eta ™ or light margarine

O Omega 3 or phytosterol margarine

O An oil (e.g.olive oil)

O Cream cheese

O Nut butter (e.g. peanut butter)

O Another kind of spread

O Don't know

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10. What type of butter or margarine do you normally use?

- O I do not use butter or margarine
- O Unsalted
- O Low-salt (less than 1% salt)
- O Normally salted (1-1.5%salt)
- O Strongly salted (more than 2.5% salt)
- O Don't know

11. How many lumps or teaspoonfuls of sugar do you usually add to <u>one cup</u> of coffee, tea or chocolate? Write "0" if you do not add any sugar.

	Teaspoons, or lumps of sugar	I don't drink this beverage
Coffee	☐	O
Tea	☐	O
Chocolate	☐	O

12. How often do you salt your food <u>after</u> it is cooked?

- O Never/rarely
- O Sometimes
- O Usually
- O Don't know

13. How often do you salt your food <u>during</u> cooking?

- O Never/rarely
- O Sometimes
- O Usually
- O Don't know

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14. How many times per week would you <u>usually</u> eat hot takeaway meals (*e.g. pizza, burgers, fried or roast chicken, Chinese/Indian/Thai takeaway)*

O I don't eat takeaway

O 1 meal or less per week

O 2-3 meals per week

O 4-5 meals per week

O 6-7 meals per week

15. How many times per week would you <u>usually</u> eat out for dinner (*restaraunt meals or friends/relatives houses)*

O I don't eat out

O 1 meal or less per week

O 2-3 meals per week

O 4-5 meals per week

O 6-7 meals per week

16. Where do you normally eat your lunch? (meal between 10 am and 3 pm)

O I do not normally have lunch

O At home

O In a student/school canteen

O in a cafeteria, restaurant, bar, fast food restaurant

O Elsewhere (please specify)

17. Where do you normally eat your dinner? (meal between 3pm and 8pm)

O I do not normally have dinner

O At home

O In a student/school canteen

O in a cafeteria, restaurant, bar, fast food restaurant

O Elsewhere (please specify)

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18. **Who normally prepares your main meal at home on working days?**

- O I do not have meals at home on working days
- O Myself
- O My partner
- O My mother or father
- O Someone else (please specify) [ ] (e.g. housemate)
- O Myself, together with............ [ ] (e.g partner)

19. **Who normally buys the groceries for your household?**

- O Nobody
- O Myself
- O My partner
- O My mother or father
- O Someone else (please specify) [ ] (e.g. housemate)
- O Myself, together with............ [ ] (e.g. partner)

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SECTION C: When, and what, did you eat and drink yesterday?

1. What day was it yesterday?

Monday O Tuesday O Wednesday O Thursday O Friday O Saturday O Sunday O

Think back to **yesterday**. In the chart below fill in the circle to indicate the sorts of meals and drinks you had at each time of the day.
(Please remember to fill in a response for both food AND drink for each time period, even if you have not consumed anything)

Snacks *include things like a biscuit or a piece of fruit.*
A small meal *would be something like beans on toast, boiled egg and bread, breakfast cereal, a pie or a pastie.*
A large meal *would be something like meat and three veg, or a large serving of fish and chips.*
You may specify ***more than one*** *type of drink for each time period, e.g. alcohol and water*

TIME	Did you eat anything?				Did you drink anything?			
	No	A snack	A small meal	A large meal	No	Alcohol	Water	Something else
6-7am	O	O	O	O	O	O	O	O
7-8am	O	O	O	O	O	O	O	O
8-9am	O	O	O	O	O	O	O	O
9-10am	O	O	O	O	O	O	O	O
10-11am	O	O	O	O	O	O	O	O
11-12noon	O	O	O	O	O	O	O	O
12-1pm	O	O	O	O	O	O	O	O
1-2pm	O	O	O	O	O	O	O	O
2-3pm	O	O	O	O	O	O	O	O
3-4pm	O	O	O	O	O	O	O	O
4-5pm	O	O	O	O	O	O	O	O
5-6pm	O	O	O	O	O	O	O	O
6-7pm	O	O	O	O	O	O	O	O
7-8pm	O	O	O	O	O	O	O	O
8-9pm	O	O	O	O	O	O	O	O
9-10pm	O	O	O	O	O	O	O	O
10-11pm	O	O	O	O	O	O	O	O
11pm-6am	O	O	O	O	O	O	O	O